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ABSTRACT

A study was conducted for the Office of Educational Research and Improvement directed toward research priorities that would further progress toward high achievement for all students. The study focused on three topics, each addressed by a panel: (1) strengthening the capacity of research for contributing to educational improvement; (2) critical transitions in learning and development; and (3) teaching, teachers' professional development, and professional communities of teachers. A general theme of the findings and recommendations is that progress toward high achievement for all students has been impeded by the belief that research, students' learning, and teachers' learning can be studied in isolation from important matters of context. Research should be assumed to be part of collaborative activities that should be conceived as problem-solving research and development. Students' learning that involves acquiring information and skills should be understood in relation to students' understanding of general principles, and students' learning in school should be understood in relation to students' activities and identities outside of school. Particular attention is given to the needs of low-income students. Teachers' professional development must be understood as constantly studying, experimenting, and reflecting on the management of complex practices and professional careers. (Contains 2 figures and 113 endnotes.) (SLD)

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Recommendations Regarding Research Priorities

An Advisory Report Presented to

The National Educational Research Policy and Priorities Board
U.S. Department of Education
Washington, DC 20208-7564

By the National Academy of Education

March 1999

U.S. DEPARTMENT OF EDUCATION
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March 1999

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March 31, 1999

Dear Colleague:

In fulfillment of our mandate to work in collaboration with the Office of Educational Research and Improvement (OERI) on the development of a Research Priorities Plan, the National Educational Research Policy and Priorities Board (NERPPB) has contracted with the National Academy of Education (NAE) to provide suggestions and recommendation for possible research priorities. The attached report, ***Recommendations Regarding Research Priorities,*** is a result of this agreement.

In addition to its contract with NAE on the matter of priorities, the Board has conducted numerous other outreach activities to elicit further guidance for the reauthorization of OERI. The Board will issue one report drawing on all these sources.

We hope you will find the NAE report stimulating and that it will encourage you to send us your comments. Please address them to

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Sincerely,

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United States Department of Education □ Office of Educational Research and Improvement

RECOMMENDATIONS REGARDING RESEARCH PRIORITIES

An Advisory Report to the National Educational Research Policy and Priorities Board

National Academy of Education

March, 1999

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EXECUTIVE SUMMARY

I. Introduction

The National Academy of Education conducted a study leading to recommendations to the National Educational Research Policy and Priorities Board regarding priorities for OERI's research agenda. The study was directed toward research priorities that would further progress toward *high achievement for all students,* adopted by the Board as the goal of its research agenda. The study focused on three topics, each addressed by a panel:

- Strengthening the capacity of research for contributing to educational improvement
- Critical transitions in learning and development
- Teaching, teachers' professional development, and professional communities of teachers

By selecting these topics, we do not imply that they are the only important issues that the Board should consider in setting its priorities. Among the other areas also in need of research are matters of assessment, public policy (including school finance), and learning environments that utilize modern technology. Although this report deals only with a limited set of topics for research, all of the issues we present are important, and all should be given high priority by the Board.

A general theme of the findings and recommendations is that progress toward high achievement for all students has been impeded by the belief that research, students' learning, and teachers' learning can be studied in isolation from important matters of context. Research should not be assumed to be separate from efforts to improve educational processes, but rather to be part of collaborative activities that may be conceived as problem-solving research and development. The aspects of students' learning involving acquiring information and skills need to be understood in relation to students' understanding of general principles, and students' learning in school needs to be understood in relation to students' activities and identities outside of school. Teachers' development should not be understood as simply acquiring skills and knowledge, but as constantly studying, experimenting, and reflecting on the management of complex practices and professional careers.

II. An Initiative to Strengthen the Links Between Educational Research and Improvement

A more effective system to link research with practice and policy is needed, because of the scope and magnitude of the educational problems we are seeking to solve. New levels of intellective competence will be needed by our whole population, and to accomplish this, the education system needs to be strengthened fundamentally around powerful pedagogies and new forms of organization that make it possible for *all* of our diverse students to learn core concepts and knowledge along with the basic skills and capacities for thinking and reasoning they will need in the course of their lives.

To progress toward an infrastructure that can support a more productive relation between research and educational practice, members of the study group recommend that the Department of Education initiate a long-term effort to develop support of collaborative educational research and improvement based on a new model of the relationship between these activities. The model, articulated by Donald Stokes in *Pasteur's Quadrant,*[1] is fundamentally different from the model of research, development, dissemination, and evaluation (RDDE) as a mainly linear process. Instead, Stokes argued (with many supporting examples) that inquiry and invention can be categorized as low or high in their potential for advancing understanding of general explanatory principles *and* as low or high in their potential for betterment of a social problem.

The NAE study group recommends that OERI begin an important new program of research in "Pasteur's quadrant," which should be focused explicitly on solving specific current problems of practice and *at the same time* should be accountable for developing and testing general principles of education that can be expected to apply broadly beyond the particular places in which the research is done.

The central idea in the study group's proposal is to develop a system of support for projects in which professional researchers and professional educators share in the accountability for achieving success in improving educational practices and outcomes. These projects may also include program developers, curriculum specialists, or policy specialists. All the participants share in a commitment to and accountability for multiple outcomes of the work:

- tangible improvement of a complex educational system, responsive to the circumstances of that system's functioning and according to documentable criteria
- development of materials, personnel, and other resources to support transport of the aims, operational concepts, and methods that are developed in the project to other sites in which people want to adopt those aims, concepts, and methods ("travel")
- contributions to the research literature that documents the results of these efforts and provides the forum in which alternative explanatory principles are developed, evaluated, and clarified, so that the results of these projects will cumulatively advance society's understanding of general principles of educational practices and processes.

The study group recommends that in selecting projects for support, segments of the population and topics for study should be chosen to promote greater equity. Programs that should be given high priority would promote student understanding in schools that serve disadvantaged communities, would develop high levels of literacy and other competencies for students who are now denied them, would move toward making good education in urban in urban school districts the rule rather than an exception, and would advance productive uses of modern technology in schools that serve children of poor families.

The recommendation's novelty is in proposing that commitment to these goals and accountability for them should be shared by all of the participants in the project, rather than being separate responsibilities of distinct communities of educational practitioners, developers, and researchers working on separate projects. Of course, the participants will come to these projects with differing expertise, differing career trajectories, and, finally, accountabilities to different communities in which they are primarily affiliated. The challenge of building this new kind of enterprise for educational research and improvement will be to find mechanisms of support, review, participation, and evaluation that value the joint achievements of these multifaceted teams.

We want to be very clear that our recommendation is *not* to *replace* support for basic research and for applied research and development activities with integrated problem-solving research and development. Rather, we believe that this kind of integrated work should be added to the program of activities supported by the Department of Education and should be closely integrated with both fundamental and applied research, which the Department should continue to support vigorously. Figure 1 shows the diagram that Stokes used to represent the relationship between the three main kinds of research and improvement that has been productive historically. The central role of what Stokes called "use-inspired basic research," which we call "collaborative problem-solving research and development" in this report, is a crucial aspect of our belief that our recommendation could greatly strengthen the ability of the educational research system to serve the nation's educational practices and outcomes.

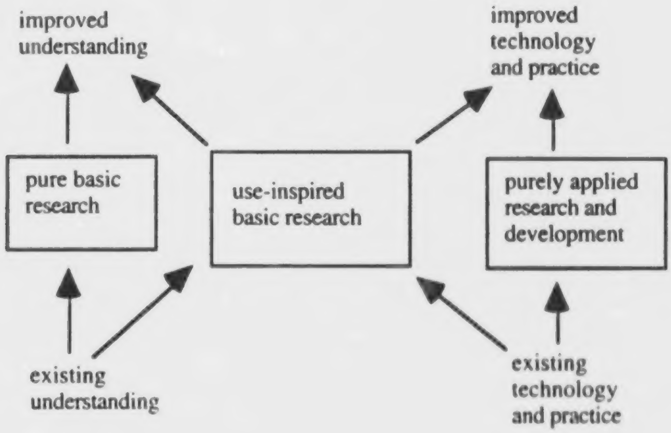
improved understanding
improved technology and practice
pure basic research
use-inspired basic research
purely applied research and development
existing understanding
existing technology and practice

Figure 1. A revised dynamic model.[2]

Our report outlines several components of a system of collaborative educational research and improvement, which was developed in the deliberations of the panel on Strengthening the Capacity of the Research System. The recommendations include supporting federations of problem-solving research and development projects, linked in a hub-and-spoke relationship. The goal would be simultaneously to develop improved educational success in specific settings (the spokes) and to identify issues of common concerns and to carry out theoretical analyses and construct tools that are supported by and facilitate the work of the several projects in integrative ways (the hub).

The program we recommend calls for new forms of research organization that are focused on practice and on engaging researchers and practitioners together in problem solving and theoretical analysis. There are precedents for the kind of problem-solving research and development we recommend, but many questions remain about what the most effective forms of organization for such research will be in the long run. In the spirit of joining research and practice, therefore, we recommend a measured start-up for this new program. A limited number of projects can be mounted in the beginning, developed through an iterative process of on-the-ground design and redevelopment, and then carefully analyzed both by participants and by the broader educational research and practice community. Expansion of the program can then be based on solid experience in how to manage forms of research and development that are focused directly on solving problems of educational practice and public policy.

We believe that this proposal will require grappling with some of the most persistent and deeply ingrained problems of our day: for example, getting all students to read by the third grade, effectively remediating reading problems that persist into the middle and high schools, and improving the quality of instruction in urban school districts. It will mean tackling problems that have social as well as academic roots, questioning the social arrangements of schooling (e.g., tracking), and taking seriously the charge to create good citizens as well as an educated workforce.

III. Research on Learning to Support High Achievement for All Students

The NAE study group's recommendations regarding critical transitions in the learning and development of students, especially low-income students, focus on two sets of issues. One involves transitions that students must accomplish in order to progress successfully through the school curriculum. The other concerns transitions that involve the social organization of learning in schools and its relation to the activities of students in the rest of their lives.

Teaching and Learning in School

The NAE study group recommends a high priority for research on critical transitions, which include important developments in conceptual understanding as students move through the school curriculum, as well as movements between the school and other communities of students' social life and work. A general problem is that to achieve at high levels, students must succeed in critical transitions that require mastery in general aspects of knowing and understanding that are often not explicitly taught. The expectations in school for these general aspects of understanding and learning do not match equally well with the expectations and practices of all students, and the transitions are much easier for students for whom the school practices are in close alignment with the practices the students bring from home. This difference is generally unfavorable to students of low income.

The study group's recommendations focus on mathematics and reading in the lower and upper grades. This does not mean that we are uninterested in, for example, history; indeed, both the NAE study group and a group of educational practitioners they convened as consultants urge attention to the development of civic responsibility. But if one cannot read complex texts fluently, one cannot study multiple texts in order to understand history. And if one cannot understand notions such as probability and chance, one is excluded from the communities of scientists and mathematicians.

Reading. Difficulty in reading in the early grades is a primary reason for school failure. The National Research Council report *Preventing Reading Difficulties in Young Children* synthesizes research that establishes the importance of early reading as a crucial first step in school success and describes the components of effective early literacy programs. Now research is needed to analyze how these recommendations are or are not implemented in K-3 programs and what factors lead to success and difficulties. There also is a need for research on how students become facile at reading complex text needed to understand advanced academic subjects such as history, social science, mathematics, and science.

Second Language Learning. The National Research Council report *Improving Schooling for Language Minority Children* provides a comprehensive synthesis of research concerning the education of linguistically and culturally diverse populations. Now we need to know (1) what specific educational interventions work well for specific populations of English Language Learners, (2) the short- and long-term academic and non-academic effects of these interventions, and (3) the techniques of assessment that can measure accurately the competence of English Language Learners.

Important transition points in the process of English language learning include: (1) the transition from the first oral language to English; (2) the transition from oral language to literacy; and (3) the transition into "academic discourse" (when a student engages written material in math, history, social science studies, etc., and uses the vocabulary and conventions of these disciplines in discourse). Research is needed on these critical transitions in the educational trajectories of English Language Learners (bidialectal as well as bilingual). In addition to making the transition to a new language, English Language Learners must learn new identities and cultural practices. For example, the language that ELLs use at home or on the playground develops differently from the language they use in the classroom. This situation is exacerbated by the fact that immigrant students arrive in the US at all ages, levels of education, and levels of literacy.

Mathematics. Difficulty in early mathematics is another important reason for school failure. Evidence suggests that many young children enjoy school mathematics and are good at it, but that starting at fourth or fifth grade, significant numbers of students start to have difficulty with the subject and to dislike it. At this point and others, there is often a transition in the nature of the mathematics being studied: e.g., the curriculum moves from the study of concrete objects to more abstract ideas. Research is needed on why students have so much trouble making the transitions and understanding formal representations, multiplicative reasoning, and essential mathematical and statistical concepts such as chance, randomness, and probability.

The Social Organization of Learning

The NAE study group concludes that high achievement for all students will not be accomplished by policies and practices that only consider students' activities in school without taking account of the competencies and practices that students, especially low-income students, develop in the rest of their lives. Several recommendations of the study group focus on ways in which the social arrangements of learning in school, as well as the content of school learning activities, need to be studied and understood to inform policies and practices that can lead to high achievement for all students.

Learning from Out-of-School Opportunities. Research on youth organizations, after-school clubs, and other learning environments shows that children from impoverished backgrounds display competence out of school that is often superior to the competence they display in school. We need to work with schools to make institutional use of this competence. The challenge is to design and test different models of after-school and summer programs that would best motivate, engage, and benefit low-income children.

Transitions to Out-of-School Activities. The hours after school and during vacations play critical roles in enabling academic success; evidence that a student can develop learning and commitment in extracurricular and after-school activities is now accepted as part of preparation for admission into higher education. Moreover, research suggests that in low-income communities high levels of participation in youth organizations, after-school clubs, and other non-school environments not only extend, activate, and enhance school learning but also allow children to display their abilities and earn praise. We need to know more about (1) types and features of after-school opportunities that most effectively motivate academic achievement and positive self-estimations; and (2) how to design and test different models of collaboration between schools and community groups dedicated to providing strong learning environments for low-income children.

Alternatives to Curriculum Differentiation. Retention, pull-out remediation programs, tracking, and segregated special education programs that stratify opportunities to learn by race, class, and gender do not result in high achievement for all students. Practitioners and researchers now need to collaborate to develop alternative strategies to promote the cognitive and social development of low-income students.

Academic Benefits of Heterogeneity and Diversity. There is considerable evidence to show that academically demanding, heterogeneous grouping is beneficial for previously low-achieving students. There is considerably less evidence to show the benefits of heterogeneous grouping for high-achieving students. Therefore a vital research question demanding an answer is: Do previously low- and previously high-achieving students benefit from heterogeneous grouping? Do students from white, middle-income families as well as students from low-income, ethnic and linguistic minority backgrounds benefit from these practices?

Generative Processes of Heterogeneous Grouping. As indicated immediately above, research has shown that there can be significant beneficial outcomes to heterogeneous grouping. Much less is known about the processes that contribute to beneficial outcomes. More generally, although there is a large literature on "cooperative learning," that literature offers little wisdom regarding instructional practices that foster student engagement with the subject-matter content and result in the collaborative processes that produce learning. Therefore we need to develop a more complete inventory of knowledge about the effective practices for teaching academically challenging curricula in groups in general, and in heterogeneous groups in particular.

IV. Research to Understand Teaching as a Professional Practice Developed Continuously Throughout One's Career

The NAE study group recommends that a high priority be given to a sustained, comprehensive, and coherent program of research in support of teachers' professional development. Without improving our understanding of what it will take to produce a well-prepared and professional corps of teachers, school improvement will not be possible. Students living in poverty and ethnic minorities have been historically underserved by American educational institutions and are an increasingly large proportion of the student population. No one doubts that teachers will have much to learn in the years to come in order to be successful in helping all students reach high levels of achievement. There should be a particular concern with producing new knowledge about connections between professional development and improving education for currently underserved populations, namely children and adolescents whose experiences and dispositions do not match with the expectations and social organization of schools.

General goals of this program of research should be to strengthen knowledge and understanding of:

- how changes in teaching practice can bring about improvements in students' learning, particularly for students of low income
- how teachers' professional development can bring about improvements in teaching practices
- how the work of teaching and activities aimed at professional development can be organized to support improvements throughout teachers' careers.

The recommended research program would adopt the perspective that teaching is a complex practice and consider the continuous learning of teaching across the teacher's career as an integral part of that practice. In supporting research with this perspective, OERI would support a significant shift from most previous research on teacher learning, which has focused primarily on the acquisition of skills, dispositions, and knowledge with little attention to how these play out in what teachers do or in what students learn.

Linking Changes in Teaching Practice with Improved Student Learning. There is a compelling need for research linking teaching and learning that can inform the national debate about aims in education, standards, and equity. We also need to provide information that can guide teachers and institutions who want to change their educational practice, particularly to reduce inequities in the opportunities of students who differ in socioeconomic status, ethnic background, and gender to learn successfully. This is especially important regarding the achievement of deep intellective competence advocated in current educational reforms. In order to take advantage of current efforts to improve teaching and learning, this research should be carried out where active programs of educational reform are already under way as well as in programs specifically designed to examine the relationship between teacher development and student learning.

The research we need would examine fundamental issues about the nature of teaching and learning, including, but not limited to, the importance of the skills and knowledge of teachers. It would place teachers' skills and knowledge in the context of a broader understanding of instruction by investigating the role of intentional action in the social systems of classrooms and schools and by taking account of the nature of social relationships in which teachers and students interact to support students' learning. It would expand our knowledge and understanding of teaching practices that are successful with students who bring different cultural resources to their own and other students' learning. It would also study relationships among the effects of teaching and relevant contextual factors, including the resources available for teachers to use in their work, the sizes and social climates of schools and classes, and the ways that schools and teachers interact with parents and other groups in their communities. It would examine, much more than past research has done, issues of what it takes *to do* effective and successful teaching with diverse populations of students.

Linking Teachers' Professional Development and Teaching Practices. We need to go beyond the vague notion of "applying knowledge and skill" to understand what effective teachers do and how they do it. Successful teaching involves much more than the exercise of skills and the application of knowledge. It also requires flexible improvisational adaptation in circumstances that emerge in the complex human interactions that constitute classroom activity. We need research to develop general understanding of these capabilities—the often invisible, but fundamentally professional actions that make learning in classrooms possible—and also to develop understanding of their growth in professional learning. This would include research to understand the roles of increased knowledge and comprehension of subject-matter concepts and methods, the role of thorough understanding of the curriculum in the subject and at the level one is teaching and in relation to other disciplines and grade levels, and the role of understanding processes of students' learning in improving teaching practice.

Because of the importance in teaching practice of adaptation to problems and resources that emerge in activity, it is likely that much of the professional learning that is needed depends on practical experience at work. Research should thus investigate how the structure of teachers' work supports or hinders their "on-the-job" learning, and what kinds of abilities are learned in particular situations that can transfer to other settings with different circumstances, including teaching students with different cultural, ethnic, or socioeconomic characteristics from those in which the teacher has been working.

Understanding and Supporting Successful Professional Development. Recognizing teaching as a complex practice requires understanding teachers' development as professional learning and understanding teaching as a learning profession. Changes in teaching practice require opportunities for teachers to practice their profession responsibly, including opportunities to improve it individually and collectively. The practitioner's active role in adapting knowledge and skills to circumstances is particularly important for teaching students who have been historically underserved by our schools.

The needed research would develop an understanding well beyond the current conventional wisdom about the requirements of teacher learning. Significant changes in professional teaching practice involve a dynamic reconfiguring of how the individual teacher perceives him- or herself in relation to a community of practice. This idea has not much affected how we think about research on what teachers need to know or on their opportunities to learn. The currently prevalent simple model of learning how to teach—the knowledge goes in during teacher education or professional development and then comes out to be used in the teachers' own classrooms—does not account for the engagement of teachers themselves in improving the practice of their profession. Such assumptions about learning are at odds with what we know about learning in any professional practice.

Research concerning teachers' learning needs to recognize that what teachers need to learn to put reforms in place is not separable from their actual teaching practices or from the developmental trajectories of their careers. Research needs to examine ways in which people of diverse cultural, ethnic, and socioeconomic backgrounds are attracted to careers in teaching and how professional development resources can help increase and maintain diversity in the teaching profession while continuing to improve practice.

Further research on teachers' communities of practice is needed, building on findings that norms of responsibility and collegial efforts at professional problem solving are the most critical factors in the improvement of teaching and learning. Important lessons can be learned from comparative studies of learning to teach in different societies, which have already shown that teachers' work and their professional cultures can support valuable learning in professional practice.

I. INTRODUCTION

America's system of public education is vital to our nation's commitment to equal opportunity. Every family should have the right to expect that its children will have a fair chance to develop the abilities they need to participate fully in the social, economic, political, and cultural richness of our society. This noble goal has not yet been fully achieved, however, and we must find ways to improve our educational system to provide more equal opportunities for learning to all of our young people.

The National Educational Research Policy and Priorities Board takes up this challenge by adopting ***high achievement for all students*** as the focus of its research agenda. To help formulate specific aims and directions for research programs, the Board asked the National Academy of Education to conduct a year-long study to result in "a series of focused research questions that can guide the education research agenda." Ann Brown and James Greeno agreed to serve as Co-Principal Investigators. In negotiation with Board personnel, we developed a plan that included three study panels, on

- Strengthening research contributions to educational improvement
- Critical transitions in learning and development
- Teaching, teachers' professional development, and professional communities of teachers

The Co-Principal Investigators recruited three distinguished researchers, all members of the National Academy of Education, to chair the panels, and these, with the Co-PIs, selected and recruited the distinguished researchers and practitioners who served as members of the panels and consultants to them. Each of the panels held three meetings in which they developed drafts of the panel reports that are the main body of this document. The panels also received very helpful substantive input from practitioners. A focus group meeting was held by the panel on critical transitions, written reactions to a written summary were obtained by the panel on teachers' development, and practitioners contributed as regular panel members and consultants to all three of the panels, especially the panel on strengthening research capacity. A preliminary report was presented to the Board at its September meeting, and one of the Co-PIs has attended each of the Board's meetings during the study.

Economic and Democratic Vitality

The Board's assignment to the NAE study group rests on a fundamental assumption or statement of value: A vibrant and energetic democracy requires a well-educated and thoughtful citizenry. We believe that providing an academically challenging curriculum for *all* students is essential for the maintenance and preservation of democracy. Students from educationally, economically, and culturally diverse backgrounds can benefit from assembling together in high-achievement learning environments to develop common interests, values, and core civic sentiments.

Because students are future workers as well as future citizens, an academically challenging curriculum for all students will also serve the U.S. economy. The U.S. workplace is increasingly diverse in race, ethnicity, gender, and nationality. The workplace is also increasingly complex in its intellectual requirements. Its demands require people to work cooperatively, engage in problem-solving activities, and communicate the results of their work in written, oral, and graphic formats.

Public schools need to foster the sensibilities and habits of mind that are required for civic life and productive work among diverse groups of people. These are the larger and fundamentally important goals that guided the NAE study group's work concerning improvement of academic achievement in school.

Some Demographics of U.S. Schools and Communities

Public schools serve an increasingly diverse population. Nationwide, 66% of students in public elementary and secondary schools are white, 17% are black, 13% are Hispanic, 4% are Asian or Pacific Islander, and 1% are American Indian/Alaskan Native. This is not the distribution of students found in large urban school districts, however. Black and Hispanic students together make up more than half the students in the nation's central city public schools.

The difficulty public school educators face in trying to teach a diverse population is reflected in performance measures. Although the gap between the performance of white and black students on the National Assessment of Educational Progress (NAEP) in mathematics, reading, and science narrowed in 1994, white students still had higher scores. And although all groups have made gains in the rate of school graduation over the last 25 years, black and Hispanic students are still more likely than white students to drop out of school.[3] Public schools also face linguistic hurdles with diverse populations. More than three million school-aged children speak English with difficulty; the vast majority of them are in large urban school districts.

The quality of schooling for poor students in rural areas also requires attention. The category of "rural" itself is complex, describing both stationary and migrant farming communities. Schools serving both stationary and migrant communities have difficulty providing a broad range of study at appropriate levels. Students from migrant farming families face educational obstacles with regular education interruptions for their families' seasonal movement between harvesting sites. They attend multiple schools in the same year and experience extended periods without instruction during the school year. Because of high transience rates, both educators and families struggle with records transfer and grade-level assessment.

Rural and urban poor students share many of the same limitations of curriculum, pedagogy, and infrastructure. Teachers in poor urban and rural schools have lower qualifications and less teaching experience than peers in urban and suburban professional neighborhoods. The schools have inadequate libraries and often lack functional science laboratories. Both poor urban students and rural migrant students can have high transience rates.

Why the Three Topics of Critical Transitions, Teacher Development, and Research Capacity?

The three topics the Board assigned to NAE are critical issues on which to focus a study of the magnitude that the Board determined NAE should undertake (additional topics are considered later). They highlight issues of crucial concern for the education of low-income students: How can research be organized to contribute most productively to progress toward the goal of high achievement by all students? What are the principal roadblocks to high achievement, especially for low-income students? What hinders teachers in developing their abilities to foster high achievement by all students?

A Theme in the Study's Findings and Recommendations

As the three study panels have done their work and the findings and recommendations of their study have developed, a general theme has emerged. We recommend it to the Board as a central problem for its consideration. This theme is that society's ability to make substantial progress toward the goal of high achievement for all students is limited by assumptions about the nature of research, learning, and teaching that cause policy-makers and practitioners to neglect important complexities associated with education.

America's system of education is remarkably successful in many ways, contrary to the prevalent view of its failings.[4] Every day, many children throughout the nation make significant progress toward academic success. Nevertheless, the society expects much more of its educational system than it is now getting. We conclude that to rise to the level of these expectations, we must develop more complex understandings of learning, teaching, and research.

The common assumptions we challenge consider researchers' investigations, students' learning, and teachers' development in isolation from larger contexts. Regarding research, it is usually assumed that the results of researchers' investigations should have important practical implications, whether or not the researchers are trying to improve educational effectiveness. Regarding students' learning, students are usually assumed to learn procedures and facts independently of their comprehension of the concepts and principles that make them understandable, and students' learning in school is assumed to occur independently of their abilities and personal identities outside of school. Teachers are assumed to develop skills and subject-matter knowledge independently of the social and cognitive challenges they deal with in their classrooms as they interact with students. We believe that the relations among all these factors must be better understood, and to do so we must think of education as a complex professional undertaking.

Of course, academics have a reputation for saying that things are complicated, and our emphasis on the need for more complicated assumptions about learning, teaching, and research fits that pattern. But we want to make it clear that our concern in this report goes beyond our intellectual appreciation of the inherent complexity of the things we study. Policies and practices based on simplistic assumptions cannot be as effective as they need to be to serve the nation's children. We believe that our society is seriously committed to high educational achievement for all of our students. And we conclude from our work in this study that to progress further toward that goal, we need to revise some basic assumptions about the nature of learning, teaching, and research and make them truer to their inherent complexity.

The usual assumptions about learning, teaching, and research are approximations that perpetuate practices that are only partially successful. Our educational system works well for some of our children, but its failures are disproportionately among children of low-income backgrounds. These inequities are the reason that the Board adopted the agenda of high achievement by *all* students.

First, consider educational research and its influence on educational improvement. Much of our nation's educational research and improvement is organized by the "pipeline" assumption that researchers produce knowledge about general principles, program developers apply that knowledge in the design of instructional materials and programs, and local educational professionals implement those programs. Contributions of this kind of research to educational practice have been substantial, but the productivity of research for practical improvements based on this assumption has been limited, partly owing to problems of translation between the various communities of people who do the work of research, development, and implementation in educational practice. A more accurate perspective would view production of knowledge and understanding, and accomplishment of educational improvement, as aspects of a single process, in which specialists in research, specialists in program or materials development, and specialists in educational practice all have essential contributions to make. This more complicated assumption can be the basis for organizing collaborative projects of problem-solving research and development. Researchers, program developers, and professional educators can share responsibility and accountability for making a positive difference in the effectiveness of a particular school. Jointly they can develop materials that support the transport of ideas and methods to other sites and that contribute to the advancement of knowledge and understanding of fundamental principles in the research literature.

Next, consider learning. Within the curriculum, the assumption that learning is simply a linear progression through a set of skills leads to locating students along a single dimension of achievement that corresponds to "normal" progress at an age level. Separate tracks are created for students who have progressed more quickly or slowly than others along the trajectory. This simple linear assumption overlooks complexities involving transitions that require students to develop more general capabilities—for example, in reading, to develop different forms of linguistic activity, and in mathematics, to develop different systems of concepts and forms of representation and reasoning. These requirements for academic progress are often implicit and therefore are differentially harmful to low-income students, whose resources outside of school are less closely matched with the habits and interests that schools implicitly require. To support significant progress beyond the level of success our schools can now achieve, school instruction needs to recognize more realistically the multifaceted nature of school achievement and to confront the multiplicity of academic needs of low-income students instead of simply labeling them deficient.

The problem of academic achievement is often treated as though it involves only the activities of students in school. This view ignores relations between those activities and what happens outside of school. Research that has examined non-school activities of low-income students has revealed significant intellectual abilities that could be taken into account in school learning, to the benefit of those students and quite possibly of all students. The assumption that school learning is self-contained neglects these abilities and contributes to the impression that low-income students lack the competencies that are required for high achievement in school. A more realistic understanding that recognizes the complicated relationships between the abilities needed in school and the abilities that students develop outside of school could support significantly greater engagement and achievement. This more realistic assumption treats school in relation to its larger context.

To be sure, we are fundamentally concerned with what happens within the institution of schooling. We also recognize that the ways in which society (and the research community) divides up education create artificial boundaries between institutions. As a consequence, we often get false impressions of students' lives. The lives of educators and students in schools are influenced by the actions of people in the family, at work, in government offices, and in community organizations.

Finally, consider the teaching and learning that teachers need to accomplish to be effective, especially with low-income students. Much discussion of teachers' learning focuses on "training", in which teachers acquire a set of skills and knowledge that is assumed to be sufficient for them to teach well. This assumption of skill and knowledge acquisition is unrealistic. Successful teaching involves flexibility, invention, and the ability to respond to challenges and problems that emerge in moment-to-moment interactions with students in classrooms. Many teachers have developed these abilities through the learning that occurs in their work experience and interactions with colleagues, but important aspects of successful teaching are left out of most professional development programs. More realistic (and more complicated) assumptions about the nature of teachers' work and about their careers could support the development of resources and programs for teachers' learning and professional development, both in their regular work and in off-site learning activities, that would help many more of them move closer to the goal of high achievement for all students.

Some Issues For Future Study

In submitting this report, we are aware that the topics of our study do not include all of the important issues facing American education. We mention three important topics here, which overlap with concerns of the panels in this study but would provide foci for research somewhat different from those discussed in this report. We recommend these to the Board as topics for future study in its consideration of research priorities.

Assessment. The Board indicated in its initial communication about this study that development of improved knowledge and technology for educational assessment was of interest; however, this topic had to be deferred because of limited resources.

"Accountability" is an increasingly important issue in educational research and practice. Current accountability measures, however, do not match the goals of most educational reforms for low-income students, especially those reforms aimed at improving their complex thinking and participation in activities of inquiry and sense-making.[5]

One issue to be considered is the limitations of norm-referenced tests that are conventionally presented in standardized, multiple-choice formats. Criterion-referenced measures, aligned with teaching and learning standards, may assess the competence of low-income students more productively than norm-referenced tests.[6] Alternative methods that are responsive and valid for guiding the instruction of low-income students should be developed and studied.

Learning Environments and Educational Technology. Reforms to help all students achieve high standards include enriching the learning environment within schools. It should be no surprise that the mere presence of computational technology does not guarantee educational benefits. Like any technology, its effects depend on its use. A productive method of research that has been called *design experiments*[7] includes development of technological resources, learning activities, and teaching practices combined with research that advances scientific understanding of learning and teaching to improve the design of resources and practices. (We discuss the need for research and improvement of this kind in more detail in section II.) The President's Committee of Advisors on Science and Technology recommended a strong program of research and development to advance the productive use of technology in American education.[8] The recommendations in that report were quite general, and it would be valuable to develop a more concrete agenda of research and development, especially regarding educational benefits for low-income children and regarding productive ways in which teachers can develop their capabilities for using technology-rich learning environments.

Cultural and Political Contexts of Schooling, Educational Policy, and School Finance. Schools do not function independently from the cultural, political, and economic structure of American society. Teachers and administrators in schools with high concentrations of low-income students face overwhelming practical problems. They often have to feed their students before school, talk to social-service agents and probation officers on their lunch hour, arrange for basic health care and child care after school, and send educational materials to homes without pens, pencils, and books. When the school district is also a port of entry for immigrants speaking many different languages, these teachers and administrators also have to serve as cultural mediators between families and social agencies, banks, landlords, and employers. In these circumstances both parents and educators have to invent and maintain complex survival strategies, leaving them with little time for the children's education.

If changes in schooling are to be significant and lasting, they must be supported with resources and understanding in the society at large. For example, regarding topics discussed in this report, although the scientific issues of learning to read and learning mathematics are relatively settled in the research community, they are far from settled in public debate, and it is not clear whether or how the society will use the information and insight developed through research. It could be especially important—and challenging—to understand ways in which public support for public education is changing as the society undergoes its current phase of diversification. Studies of the formulation of educational policy and decisions about funding would examine important questions about constraints and opportunities for educational change, as would studies of whether and how policies promulgated in state or federal education agencies actually affect educational practice.

Although not explicitly addressed in this report, we also believe that there are important issues related to education policy and school finance that should be part of an ongoing research agenda. Policy research focuses on how policies get translated into practice at the school and classroom level. Policy research today analyzes how policies can support instructional improvement, i.e., how the structural, organizational, managerial, fiscal and larger policy context can support good instruction and improved student learning. As research on learning produces more findings, design interventions building on that research will need to be created. Those interventions will need to be tested and, as importantly, their organizational, fiscal-resource, managerial, staffing and instructional support aspects will need to be understood.

Past research on education policy identified its fragmented and non-coherent character and helped to spur the current standards-based education and now comprehensive school reform movements. Other policy research has helped educators understand how and why policies do or do not get implemented, how to design effective decentralization and deregulation policies, and why policies need simultaneously to address capacity development within an accountability, incentives and rewards framework. Though initially concerned with fiscal equity, school finance policy and research is now focusing on issues of educational adequacy and its cost, how to improve educational productivity, and how to reallocate the current and relatively high levels of educational resources to more effective uses. Newer policy research has also stimulated a growing national conversation about how to change the structure of teacher compensation, to pay more for teacher professional expertise as well as to provide bonuses to all in schools that improve student performance. Finally, policy research has raised fundamental questions about current educational governance structures, with recommendations for governance changes that range from mayoral takeover, to eliminating school boards, to charters and vouchers—all of which are being tried and need solid research assessment.

II. STRENGTHENING RESEARCH CAPACITY FOR IMPROVING EDUCATION

II.1. The Panel's Mission

The Panel on Strengthening the Capacity of the Research System was charged with recommending how OERI could strengthen research capacity for contributing to educational practice and public policy. This broad charge reflects dissatisfaction by practitioners, policy makers, and researchers alike with the historical and current relationship between research and practice.[9] Many practitioners and policy makers believe that researchers talk mainly to each other and fail to tackle some of the most important and pressing problems of education. Researchers, for their part, often feel that relevant research is ignored when important educational decisions are made, and they wonder how they can effectively enter the public conversation about educational ends and means.

Although they may differ about why this situation exists, both sides agree that the nation is, at the very least, failing to benefit fully from the investment it makes in education research. Both are also searching for ways to improve the situation, recognizing that we are likely to need more than just more numerous and better "dissemination" efforts to convey the results of research to potential users.

The need for a more effective system to link research with practice and policy derives directly from the scope and magnitude of the education problems we are seeking to solve. Much higher levels of literacy and scientific and mathematical competence will be needed in the next century than we have today. What is more, these new levels of competence will be needed by our whole population, not by just a few who have been selected as future leaders of society.[10] The education system broadly construed (including informal as well as formal educational institutions and encompassing multiple forms of institutional and interpersonal organizations) needs to reinvent itself around powerful pedagogies and new forms of organization that make it possible for educators to teach effectively and for all of our diverse students to learn core concepts and knowledge along with the basic skills and capacities for thinking and reasoning they will need in the course of their lives.

Expectations for much higher achievement than American schools have known in the past are embodied in the standards now adopted in virtually every state.[11] Accompanied in some states by new forms of testing and accountability, the standards movement is creating a sense of moral urgency surrounding education reform. Large problems that have been allowed to develop without adequate attention are now visible to everyone. Consider a few examples.

Reading and writing. We need to find ways to make sure that every child learns to read during primary school and to provide effective "catch-up literacy" education for those who need it, including immigrants and those whom the education system has failed the first time around. We also need to make sure that Americans' literacy does not stop with the simple forms of reading that used to be good enough for most people. People need to know how to write well also, and they need to be able to understand and analyze complex texts, something only a minority of our students can now do.[12] Existing research directly relevant to this problem is not being fully put to use in our schools,[13] even as many issues related to literacy education are left untouched by research. A new joining of educational research and practice could make substantial progress toward achieving high levels of reading and writing competence in our entire population.

Effective learning in urban school districts. America's urban school districts are struggling.[14] Filled with challenging populations of students, including many who have only recently arrived in this country and others who have been chronically undereducated, urban schools have inherited outdated systems of organization and, often, a poorly prepared teaching force. There is no shortage of demonstrably workable ideas for teaching almost any subject or topic in the school program to any of America's children. There are multiple examples of whole schools that educate urban students well.[15] But making good education in urban school districts the rule rather than an exception that depends on extraordinary people and exceptions to standard operating procedures is still a problem.[16] A sustained and systematic attack on taking effective forms of teaching "to scale" in urban school districts could make a real difference in achievement. Such an undertaking—considering questions of organization and incentives as well as pedagogy and community-school relationships—calls for a new alliance and new forms of collaboration among practitioners and researchers.

Technology. Technology will be everywhere in our children's future. People who do not know how to use it will be isolated from opportunity, and the country as a whole will suffer from missed chances for economic growth and civic exchange. Furthermore, technology can make the teaching of almost all school subjects more powerful, although rarely in the simple way we used to imagine—just "delivering information" more efficiently. The education system may well be the last major sector of our society to join the technological revolution. *That* it must join seems beyond doubt. But how to do it well—how to educate both *with* and *for* technology and how to use technology to increase equity rather than widen current gaps between the "haves" and "have nots"—remains a challenge.[17] Anecdotal evidence of successful technology programs in education abounds; careful analysis of both successes and failures is far more rare. Meanwhile, large amounts of private money are spent on introducing technology into education. We might crack the technology problem if researchers and practitioners joined in forms of research that combined analytic and practical goals and methods.

To address these and other pressing issues facing American education, we recommend that OERI establish a new program of problem-solving research and development. The program we recommend calls for new forms of research organization, focused on practice and on engaging researchers and practitioners together in problem solving and theoretical analysis.

We also recommend selecting segments of the population and topics for study to promote greater equity. For example, the new program should favor attempts to create mathematics classrooms that promote student understanding in schools that serve disadvantaged communities over those that try to do so in elite suburban schools. Similarly, priority should be given to studies focused on topics with strong links to equity, that is, to studies in core areas that link closely to changing the educational status of poor children. Examples of these core areas would include early literacy as the foundation of later learning, and algebra as a gatekeeper to careers in prestigious high-paying fields.

For the present, our proposal should be viewed as an important ***addition*** to OERI's portfolio of research and dissemination activities rather than as a replacement for current programs. There are precedents for the kind of problem-solving research we recommend, but many questions remain about appropriate methods[18] and effective forms of organization. In the spirit of joining research and practice, therefore, we recommend a measured start-up for this new program. A limited number of projects can be mounted in the beginning, then developed through an iterative process of on-the-ground design and redevelopment, with careful analysis both by participants and by the broader educational research and practice community. Expansion of the program can then be based on solid experience in managing forms of research and development that are focused directly on solving problems of educational practice and public policy.

We believe this method will require grappling with some of the most persistent and deeply ingrained problems of our day: for example, getting all students to read by the third grade; effectively remediating reading problems that persist into the middle and high schools; successfully integrating technology into teaching and learning; and improving the quality of instruction in urban school districts. It will mean tackling problems that have social as well as academic roots, questioning the social arrangements of schooling (e.g., tracking), and taking seriously the charge to create good citizens as well as an educated workforce.

II.2. Models for Research and Practice

Historically, the relation between research and practice in education has been troubled.[19] The field of education does not have a strong, well-established professional community that takes as its charge the design and development of practice-relevant theory, products, and procedures based on established scientific principles and data. There are important examples of such design and development work, but it does not occupy a sufficiently stable and extensive community of researchers and developers. The field does not include a sufficiently established institutional home, form of professional identity, or set of incentive structures that can be called on to support sustained attention to a continuing, integrated set of activities aimed at solving pressing educational problems and developing sound educational theory.

Worst of all, education lacks a well established tradition of mutual accountability between education research and practice. There are examples of collaborations in which researchers and professional educators join in shared accountability for educational improvement and advancing research, but these are exceptional. In most cases, researchers are expected to study important educational questions, but their work is judged almost entirely by its quality as research; the relevance of the work to the details of education practice is secondary, despite frequent attempts to document some kind of "impact." On the other side, knowing research, seeking it out, and acting in accordance with its results (even when these results challenge some traditional and favored ways of doing things) are exceptional rather than normative behaviors for working educators. Furthermore, regarding contributions to the research literature, professional educators are generally viewed, by themselves as well as by researchers, as the objects of study, rather than as participants in constructing knowledge and understanding general principles.

This situation is not new. The history of OERI and its predecessors (the National Institute of Education, the U.S. Office of Education within the old Department of Health, Education and Welfare) is in part a tale of trying to establish, nurture, and sustain a more productive relationship between research—the source of a reliable knowledge base for education improvement—and educational practice. The conceptual basis for much of this work (the Research-Development-Dissemination-Evaluation [RDDE] model[20]), however, embodies a set of assumptions about the way in which research and practice should interact that we want to question.

In the past, researchers typically have taken responsibility for producing new knowledge that relates to some aspect of learning, pedagogy, or schooling and for disseminating that knowledge through the traditional academic venues of scholarly journals and meetings. Others, often education practitioners, have assumed the responsibility for designing educational products and programs, sometimes based on research data but more typically based on experience and intuition, in response to specific problems. Pressures to be pragmatic and move on to the next problem often mean that practitioners devote little time to analyzing how their programs work or how they may be useful in other settings.

There is a second dimension of the research-practice "disconnect"—the gap between what we know and what we do with what we know. No matter how we conduct our research—through surveys or ethnographic methods or "design experiments"—we need to develop better strategies to ensure that research findings will have a wider impact in schools and communities with significant numbers of low-income students. For the most part, we have treated the intersection of research and practice as one in which researchers transmit the products of research to practitioners. This situation is ironic, for we know that the transmission model does not work for the education of children. Why, then, do we think it should work for the education of practitioners?

The RDDE approach to research and practice has proven to be unproductive and myopic. When researchers take little or no responsibility for making things work and practitioners eschew the development of explanatory systems for how and why things work or not, neither research nor practice benefits. Without a sense of mutual obligation to one another, researchers and practitioners continue in their own worlds, talking past rather than to one another.

An Alternative to RDDE

Despite these limits, RDDE (so named or not) has persisted as the main conceptual basis of our research and improvement system. This is partly because no plausible alternative to the present relationship between research and practice in education has been available. Now, research in the history of science and technology provides a basis for a new framework for thinking about research. Donald Stokes[21] has suggested that the relation between a science and its societally useful applications is best thought of not as varying along a single basic-applied dimension but rather in two dimensions: degree of attention to formulating general principles and degree of attention to use. A research program can be either high or low along each dimension. So in contrast to current stereotypes, research can be high in use orientation without thereby being low in principles orientation. Stokes's conception, then, provides a framework for thinking about research that is simultaneously basic and applied.

Stokes illustrated the four quadrants he created by crossing the two dimensions with prototypes of historically important research programs (see figure 2). His example of the high use/high principles quadrant was Pasteur, whose career was strongly concerned with both changing medical practice, including developing methods of vaccination and sterilization in surgery, and understanding basic biological mechanisms, which included basic research to study how microorganisms transmit disease and cause fermentation and to demonstrate that microorganisms are present in the atmosphere. By contrast, as Stokes noted, Thomas Edison focused on use-oriented invention in his development of commercially profitable electric lighting, with little concern for developing general principles, whereas Niels Bohr focused on principles of physics in his development of a model of atomic structure, leaving questions of use and application to others.

Research is inspired by:

		considerations of use? no	considerations of use? yes
Quest for fundamental understanding?	yes	pure basic research (Bohr)	use-inspired basic research (Pasteur)
	no		pure applied research (Edison)

Figure 2. Quadrant model of scientific research.[22]

We believe that OERI should continue funding basic and applied research, but at the same time we recommend that it establish a new program of research and development in "Pasteur's Quadrant." This new program would be based on a model of research and communication that assumes that much useful knowledge about education practice must be jointly constructed by researchers and practitioners.

This research should be focused explicitly on solving specific current problems of practice and *at the same time* should be accountable for developing and testing general principles of education that advance fundamental understanding and can be expected to apply broadly beyond the particular places in which the research is done. We believe this can be best accomplished through specially organized forms of *Problem-Solving Research and Development* (a version of what Stokes called "use-inspired basic research"), a concept that we elaborate presently. At the end of section II, we discuss ideas for OERI's appropriate role in sponsoring research in the other quadrants identified in figure 2. We also discuss how our proposals might affect thinking about OERI-sponsored institutions such as research centers and regional laboratories. The bulk of section II, however, is devoted to explicating the concept of Problem-Solving Research and Development and the ways in which OERI might build the targeted federations of researchers and practitioners that, over a five- to ten-year period, can be expected to build a strong new capacity in the U.S. for education research that will be both useful and principled and that can provide a practical grounding for meeting the high learning goals for all of our children to which the nation is now committing itself.

II.3. Problem-Solving Research and Development

In the course of its deliberations, the panel sought out and analyzed existing research and development programs in education that could help specify some important characteristics of work in Pasteur's quadrant: that is, research that would improve education practice and results in the short and medium term and at the same time build an expanding set of principles for education's future. The panel found a number of examples of projects and programs that engage researchers and practitioners in complex forms of research and development and that appear to be yielding knowledge likely to be of use beyond the local settings in which the work is proceeding. They range in scope from research on entire school districts' reform efforts, to the design of innovative curricula, to fundamentally different social arrangements for learning in classrooms, to research on individual schools or specific sub-populations of American students. They engage researchers from multiple disciplines. Much of this research is focused on instruction, learning, and social organization of schooling for the nation's increasingly diverse population of school children.

From these examples, the panel developed a definition of Problem-Solving Research and Development that captures several essential features:

1. Commitment to the Improvement of Complex Systems

   This work is not meant to solve narrow-bore problems whose remedies create isolated islands of excellence. Rather, participants will take on broad-based problems that are widely regarded as critical and real for education and, therefore, necessarily embedded in complex systems. The problems and their solutions will be deeply rooted in issues of teaching and learning within the complicated organizational structures of districts, schools, and classrooms. Participants express their commitment to improved practice and outcomes through their unwavering focus on and acceptance of responsibility for the influence of their work on what students learn and how the particular educational systems in which they are working function.

2. Co-Development by Researchers and Practitioners, with Recognition of Differences in Expertise and Authority

   Researchers and practitioners work together to frame the problem and its solution. Together, they identify the features and boundaries of the problem space; decide what additional information needs to be gathered or analyzed in order to understand the problem more fully; and develop tools, approaches, and expertise to solve the problem. As they work together, researchers and practitioners develop a common vision and a shared language. At the same time, they retain and respect the unique forms of expertise and domains of authority that each brings to the table. For example, when decisions on aspects of practice must be made, researchers are actively consulted, but practitioners' judgments are accorded greater weight.

Similarly, practitioners are active in formulating questions and interpretations of data, but when decisions about methodology or other technical matters must be made, researchers' judgments are accorded greater weight.

3. Long-Term Engagement that Involves Continual Refinement
The intensive interaction between practice-based activity and research that we envisage demands a stable set of professional relationships among participants who are committed to using data and evidence to critique and progressively refine their emerging designs and understandings. The improvements we seek will be based upon constructing designs, testing them, revising them, and retesting them in continuing refinement. Such work does not occur in a vacuum, but rather emerges from consistent interactions among a steady group of participants over a long period, during which mutual trust and respect gradually develop.

4. Commitment to Theory and Explanation
Simply solving a local problem is not enough to qualify as Problem-Solving Research and Development. In addition to creating education programs and redesigning education systems, these kinds of projects will develop articulate explanations regarding how and why things do or do not work. Participants view themselves as accountable for generating and testing general principles as well as for producing theories and explanations that ensure that the work done in one site contributes to fundamental knowledge and understanding and is of broad use to the field. This commitment to principled explanation is an obligation of all team members, both practitioners and researchers.

Among the array of existing research and development programs we reviewed, the panel found excellent examples of each of the features above, although few, if any, programs displayed all of them. All the projects that served as examples for the panel's deliberations took on complex and broad educational problems in ways that recognized a problem's interdependence with the cultures of schools as organizations and the communities that they serve (Feature 1). The foci of the programs included the development of effective learning environments in urban school districts in Chicago[23] and New York City,[24] the design of an early intervention program for first-grade children identified as most at risk of failure to learn to read,[25] the improvement of mathematics instructional programs in urban middle schools serving disadvantaged communities,[26] the development, refinement, and integration of technologies and inquiry-based curricula to support science learning,[27] the design of a school-wide elementary reading program targeting disadvantaged populations,[28] and the development of a video-based macrocontext for complex problem generation and problem solving.[29] Although all of the projects we reviewed developed deep commitments to improving the sites where they were working, the criteria used to judge success and the consequences of failure varied.

In the examples discussed by the panel, research and development tasks were shared between researchers and practitioners (Feature 2) in different ways. Co-development ranged from in-depth conversations leading to the identification of broad areas for investigation and agreed-upon frameworks for shaping the interpretation of data[30] to much more targeted co-development of specific processes and products (e.g., joint development of curriculum,[31] of project-based curricula and supporting technologies for teaching science,[32] and of approaches to teaching middle school mathematics[33]). The crucial ingredient of co-development is mutual investment by both the practitioners and the researchers in the problems under investigation and in ways of framing and attacking those problems. In their joint enterprise, researchers and practitioners bring different sets of skills to the table. For example, in the technology-enhanced project (Co-Vis), the researchers brought a vision of project-based pedagogy and implemented computing and telecommunications infrastructures to support it. The teachers turned the technological tools and vision into a concrete set of activities, which they anchored onto a coherent curricular frame that could be passed on to other teachers.

Many of the projects we discussed extended over several years, some over decades. This long-term investment represents commitment to both the people and programs at specific sites and to continual refinement of solutions to the problems on which they were focused (Feature 3). For example, KEEP researchers worked in the Kamehameha setting for 10 years continually evaluating and refining their instructional program.[34] The initial development project for Reading Recovery (the early intervention program for at-risk readers) was followed with a continuing research-and-development program that included field trials and numerous follow-up studies. Brown and Campione's project, Fostering a Communities of Learners,[35] developed curricula and classroom activity structures with teachers and modified the materials and methods in light of their experience over a multi-year period.

Commitment to theory and explanation (Feature 4), when present, has taken several forms. Some projects have been more focused on the production of tools, defined processes, and other forms of conceptual scaffolding that will help others in comparable situations who are attempting similar reforms. Many of Success-for-All's contributions, for example, have come in the production of curricular tools along with the explication of system-building supports that must be present in order to ensure success (e.g., 80% of the teachers must agree to implement the program, tutors are necessary for the earliest grades, full-time facilitators and a family support team are essential). In a somewhat different, but related vein, the research protocols and frameworks used during the QUASAR project have been developed into professional development materials and forms of conceptual scaffolding for others attempting middle-school mathematics reform.[36]

Contributions to theory and basic knowledge were somewhat more difficult to find, although KEEP is a stellar example in this regard. The ten years of the Kamehameha laboratory-and-demonstration school's existence coincided with a time of significant research on language development and literacy learning—research that the KEEP researchers and educators both drew from and contributed to. Of particular interest to the R&D team were studies comparing the ways children and teachers interact in instructional settings with the ways those same children interact with adults and other children at home and in the larger community. Such studies highlighted the interwoven nature of social interaction, language development, and achievement of literacy, and they suggested that a child's literacy is speeded by instructional interactions that are compatible with the child's natal culture. This work has made long-lasting contributions by debunking deficit notions of minority populations; by highlighting that effective literacy teaching requires attention from all levels of the organization, from student-teacher interactions to administrative structures and functions; and by offering a rich model for teacher preparation and professional development.

II.4. Ensuring Usefulness Beyond the Research Site

Problem-Solving Research and Development of the type we advocate calls for intensive work at one site or a small number of related sites. Only by working in an intensive way can the commitment to improving practice and outcomes in a functioning education system be realized. Because of this local commitment, there must be planned, systematic attention to "what travels" from a Problem-Solving R&D site to other sites. OERI will need to build into its programs expectations and support mechanisms to encourage local problem-solving teams to look beyond their immediate situations.

Education solutions do not travel with ease.[37] A program or process that functions well at an original development site can rarely be disseminated by simply describing the process and expecting others to replicate it. These difficulties with replication occur partly because description alone rarely conveys enough detail to permit faithful re-enactment. People interpret innovations through the lens of what they already know.[38] Without a firm and deep understanding of the principles that underlie the innovation, their local adaptations will frequently be misguided. Difficulties with replication are also partly due to variability across education sites (variability in student population, staff capabilities, organization, and political context); therefore, successfully using ideas and processes developed elsewhere almost always requires adaptation and re-implementation or re-design to some degree. Even highly structured curriculum materials—which might compare, for example, with prescribed drugs for specific medical conditions—require local learning and a significant degree of local adaptation to function effectively once they move beyond an initial R&D site.

For all these reasons, the panel wants to replace the familiar concept of *dissemination* of research and development results with the concept of encouraging *travel* from site to site. Solutions to complex problems cannot be encapsulated in journal articles, reports, or boxes of materials. We thereby advocate moving beyond the simple idea of dissemination to building capacity for broad-scale improvement. Such capacity will typically involve simultaneous developments along three dimensions:

- *well-articulated ideas and principles*—the theories and explanations that lie behind the solutions worked out at specific R&D sites
- *tools and defined processes* that can help people use ideas and programs in new places
- *people* who are very familiar with the principles and practices developed at an R&D site and who are able to assist schools or districts wanting to use solutions based on the original R&D work.

Ideas and Principles

A first responsibility of Problem-Solving R&D teams is to attend to the problems identified at a site and to develop solutions that work there. But, as we have noted, solutions that work in one place can rarely be simply adopted in another. Almost invariably, new sites adopting a research-based practice will also need to adapt it to fit local conditions. The resulting variations in a practice, sometimes apparently small and unimportant, may turn out to violate important aspects of the practice as it was designed and studied at the original development site. Thus the adopted practice may fail at the new site.

One important way to make designed practices more robust as they spread to new implementation sites is to make the *principles* underlying the design explicit. New users who understand the underlying principles of an educational practice or program will be able to move beyond simply copying its surface features. They will be better able to craft a local implementation that honors the underlying principles of the designed practice; that is, they will be more likely to avoid modifications that in fact vitiate its effectiveness. At the same time, their understanding of the underlying principles of a research-based practice will free them to develop new variations that may turn out to be even more powerful than the original model.

Primarily because of the power of well-articulated principles to both constrain and empower effective new implementations, we have stressed the need for local problem-solving teams to be committed to the development of theories and explanations for their solutions as well as to finding solutions that work locally. In Subsection II.5, we suggest how the linking of problem-solving sites in specially designed "hub and spokes" R&D confederations may contribute to the more powerful development of principled explanations and theories.

Tools and defined processes

Another way to facilitate the travel of education solutions from site to site is to construct tools and defined processes of engagement. Research in the Vygotskian tradition,[39] along with historical, social science, and behavioral research on the functioning of various professional communities,[40] has made it increasingly clear that tools, especially those that help us observe and measure phenomena, embody theories of what ought to be taught or learned, how people learn, how professional groups ought to function, and what is important about community attitudes. Tools—including student assessments, curriculum and professional development materials, software programs, questionnaires for probing community attitudes, and protocols for observing classrooms or professional meetings—are powerful carriers of theory and knowledge. Carefully designed tools that educators find useful in their practice can, then, become a powerful means of changing educational practice. Similarly, defined processes for such activities as conducting school visits, organizing professional development opportunities, or supervising school principals are *de facto* representations of what an educational idea would look like in practice. Such defined processes can, therefore, help to support new implementers of a research-based design to act in accord with the principles and theories underlying the design. Problem-Solving R&D teams should be strongly encouraged to build and test tools and defined processes that will help their solutions travel faithfully to other locations.

People

The experience of those who have been involved in Problem- Solving R&D makes it clear that well-articulated principles and well-designed tools and processes alone will not ensure the successful travel of their solutions. Virtually everyone working in this field who is committed to seeing his or work spread beyond the original R&D site has found it necessary to provide some form of technical assistance to new implementers. This almost always means that people very familiar with the core research and development will work directly with educators in new implementation sites.

Collaborative work takes many forms. Some R&D projects train significant numbers of students and technical staff who later move to other sites or to related R&D projects. This movement of students, post-docs, technicians, and practitioners who have had experience in Problem-Solving R&D is a major way in which capacity for this form of education research develops and spreads. It works to the extent that there are new opportunities for Problem-Solving

R&D activity around the country, and it depends on a stable and at least gradually expanding funding stream for such practice-embedded research. Some projects develop technical assistance teams that are available for consultation at new sites. An important example of this strategy is provided by Success for All, which, from a practice-based research and development start in a handful of local schools, has developed an extensive network of schools that have adopted its school design, using structural materials along with a training staff that supports school staffs. Other projects develop structured seminars and study groups, along with on-site consultation, to help schools and districts to design and implement programs based on the results of the research. For example, the Institute for Learning's partnership and seminar program[41] helps transmit to other districts the research conducted in New York City's Community District #2.[42]

Combining Local Problem Solving with a Commitment to Fostering Travel and to Advancing Knowledge and Understanding of General Principles

Several ways of ensuring understanding and use beyond the Problem-Solving R&D site have proven utility. The panel noted, however, that many projects meeting most of the criteria laid out in section II.3 continue functioning for many years without focusing attention on how their results might become useful beyond the development site. That is, they publish and speak about their work but do not support it with traveling tools and process supports or develop supporting staff to help would-be implementers at other sites. Yet another opportunity is often missed as designs travel and begin to get used at other sites. Much can be learned at this stage that should be subsequently fed back into the development and travel cycle. Finally, research done at specific sites needs to go beyond outcomes-based evaluations to the kind of analytical study that is required to contribute to the research literature that develops knowledge and understanding of general principles.

The NAE study group recommends that OERI establish a funding program in which participating Problem-Solving R&D projects accept a specific commitment to design their work so that their solutions and ideas can travel successfully beyond their own research sites and to contribute their results, analyses, and proposed explanations to the research literature. This implies a considered and reasonably funded effort not just to find workable solutions but also to generate and publish principled analyses of the work that can be used by others and considered in the research community. In addition, at appropriate points in the project's life, explicit attention would be given to developing tools and methods that can help other sites adapt the strategies developed by the research team. Projects should also be expected to develop appropriate forms of "people" support for travel. This could take the form of partnering with other organizations skilled in technical assistance as well as developing internal capacity for delivering assistance.

A commitment to designing for travel within OERI's Problem-Solving R&D program should not mean that every funded project must throughout its life be designing tools, providing technical assistance, and contributing to the research literature. Many projects are likely to need a period of time, perhaps several years, in which their work is primarily invested in their initial research sites. The OERI program as a whole, however, must treat travel as one of its core commitments, and this implies that, at any given time, several of OERI's Problem-Solving R&D projects should be attending to travel and contributing to understanding of general principles. This will mean, no doubt, that OERI will require all projects to take on these concerns—either directly or in alliance with other projects—at some time during the course of their work.

A Special Case: "Going to Scale" as a Problem for Research and Development

It is likely that even requiring all projects to devote some of their human and financial resources to helping their ideas and solutions to travel will not solve the problem of spreading the results of R&D or taking promising educational solutions "to scale." Across the education landscape, many schools and R&D projects have been demonstrably successful in educating students in a few locations. But it has proven difficult to spread these practices widely.[43] The problem of "going to scale" needs Problem-Solving R&D of its own. Research is needed to understand the occasional cases where strong practices *have* spread effectively and, equally, to understand the blockages and constraints that normally inhibit spread. In the spirit of problem-solving, research teams studying the going to scale problem should also be designing and testing solutions. In sum, the panel recommends that, within its portfolio of Problem-Solving R&D projects, OERI consider funding one or more projects that are explicitly aimed at studying and developing solutions to the problems of "going to scale."

II.5. Linking Problem-Solving Projects for Maximum Capacity Building

We recommend that OERI establish an ambitious new program explicitly designed to link research and practice. The preceding sections of this report have outlined our conception of Problem-Solving R&D as a particular form of research that, when combined with continued efforts in both basic research and applied research and development, is most likely to create solutions to pressing education problems, well-grounded theories and explanations of educational processes and effects, and the tools and assistance capacity that can help research-based programs to spread effectively through the nation's schools.

In this section and the next we consider how to "bootstrap" what is now at best a modest capacity for the kind of problem-solving research we are recommending into a robust new R&D capacity.

We have said earlier that we are recommending a portfolio of Problem-Solving R&D projects, working in multiple sites on different problems and using different theoretical orientations. Diversity among the projects funded is important as a new form of research capacity is developed, for it is neither possible, nor wise, to try to predict in advance exactly where the problem-solving breakthroughs will occur. At the same time, simply creating a collection of projects and leaving to chance the extent to which they develop synergies and cross-connections—in ideas, in personnel, and in receptive environments for Problem-Solving R&D—is not likely to enlarge the nation's capacity for linking research and practice quickly. We therefore considered strategies for deliberately linking research projects in ways that would enhance both the quality of individual projects and the effectiveness of OERI's Problem-Solving R&D program as a whole.

Our proposal for accomplishing this linking is to form federations of Problem-Solving R&D research projects. Projects with related intentions would be linked in a hub-and-spokes relationship. Each spoke in a federation would be an independent Problem-Solving R&D project, staffed by senior researchers and practitioners and funded on the basis of the quality of the concepts, methods, and design strategies set forth by team leaders. The hub team for each federation, also staffed by senior researchers and practitioners, would be charged with searching out and articulating issues of common concern across the sites as well as creating theoretical analyses and tools. These analyses and tools should allow the work of the spoke teams to cumulate more quickly and more powerfully than if the spoke projects worked only independently.

A hub team in a Problem-Solving R&D federation will have multiple functions. One very important function is to enhance the generalizability of the research throughout the federation, supporting theory development and tool building and perhaps creating clusters of people able to move across research and new implementation sites. The concept of working across specific projects to find principles and theories that are general in a field of investigation is not new. The search for generalizations across particular studies is, in fact, the very foundation of research communities committed to accumulating knowledge. Many mechanisms (ranging from refereed publication to professional meetings to topical conferences to meetings of principal investigators) are already in place to support cross-project accumulation of knowledge and mutual accountability. But the processes currently available are slow and do not, for the most part, lead to a focus on principled practices and tools usable by practitioners as well as theories used by the research community itself. We believe that, in the context of the kind of Problem-Solving Research and Development we are recommending, it is possible to enhance and accelerate the process of generalization by deliberately charging federation hubs with the task of cumulation and providing the resources needed to do this job effectively.

Hubs might work in many ways. Convening spoke investigators from time to time for discussions of planned research and early results can create a distilled and powerful form of "quality control" in the federation as researchers in the various spokes become accountable to each other for the quality of their research designs, conclusions, and tools and processes for going to scale. Working in this way, hubs can be an important counterweight to pressures—created by the demand for spreading research-based practices quickly—to make claims that are not fully supported by the available evidence.

Hub leaders can also lead in integrating the emerging frameworks and observations from the various spokes; conducting comparative analyses and forcing attention to conflicting findings or differing interpretations; and drawing out general principles from local variations. The hub team may also develop—in concert with spokes representatives—common questions and methods of data collection that all of the spoke projects agree to address or use. In some cases, it may be useful to think of the spokes of a federation as a series of "natural experiments" in redesigning aspects of education practice; the hub might then draw conclusions across the different experiments composing the federation.

Hubs can also directly promote "travel" of the theories and problem solutions created throughout the federation. Even when problem-solving research teams are actively seeking to generate and test theory and principles, research in any single site (or even a small collection of sites) will, by its nature, generate theories and explanations that are in some respects specific to the site. To the extent that this is so, solutions and principles developed in one site will have difficulty traveling to other sites. To counteract this tendency, a positive, intentional effort to develop principles that generalize across sites will be needed. Hub teams might focus especially on usability and going to scale. Hubs might also help to create the tools, processes, and human resources essential to "travel" of the work conducted at the spokes.

We have outlined here some possibilities for how hub-and-spokes federations might function, with particular attention to the role of the hub. We have focused on the hub functions because this is an underdeveloped aspect of research and development that we believe needs explicit nurturing in a new OERI program. But the fact that there are so few examples of successfully functioning problem-solving hubs means that our proposals are more speculative than they are for spoke R&D teams.

Multiple examples do exist of research ventures in which a central group designs a study that requires on-the-ground research in multiple sites. Associates at the sites are recruited, but in most instances agree to follow a centrally designed research protocol. Most of the interpretation, if not the data analysis, is carried out at the center, with little or no independent role for researchers at the sites. The hub-and-spokes federations we recommend are not intended to function in this way. The people leading the spokes' design teams will need to have both ability and stature that will allow them to formulate the questions and to work with local constituencies as well as to interact directly with the broader research and practice communities. But in the federation model, they would also have to agree to join the hub-and-spokes system understanding that there will be a subset of research and practice leaders whose job it is to look closely across sites for common issues or problems, and that these people will have an influence on the federation as a whole.

We can point to some positive cases of hub-and-spokes research federations of this kind that seem to be successfully cumulating evidence and creating generalizations that reach beyond individual projects.[44] But at least as many attempts to form hubs appear to have foundered. It would be well to study these cases as efforts to build more effective hub and spokes federations get under way. Among the issues to be considered are the optimal kind and degree of compatibility and variation among the programs at the spokes, the kind of incentives that encourage the cooperation of individuals at each of the spokes with the hub needs and activities, and the ideal composition of the hub team.

Although there is room to experiment with many specific organizations and functions for hubs in research federations, OERI will need to invest strongly in the hub function and not leave integration across sites to chance. This is likely to mean not just investing financially in hubs, but also helping to launch them and, during the initial years of the Problem-Solving R&D program, tracking successes and failures and shaping up effective hub-and-spokes federation designs. We say more in Section II.7 about possible ways OERI might organize to carry out this nurturing and guidance function.

II.6. Incentives and Long-Term Capacity Building

For our recommendations to be carried out successfully, the newly formed federations (hub and spokes configurations) must be staffed by the highest quality researchers and practitioners. In this section, we discuss the incentives needed to attract and hold the best and the brightest among both the researcher and the practitioner ranks.

Researchers

We believe that some researchers will be captivated by the creation of a new social arrangement for the conduct of educational research: deriving theoretical principles from solving real problems in education. For researchers eager to work on our most compelling educational problems, the excitement of working closely with practitioners in schools and classrooms, plus the opportunity to join colleagues nationally to build generalizable understandings, tools, and insights, will provide ample incentives to participate. We predict that the people who apply for funding will be among the most forward-looking and entrepreneurial of their ranks.

Ideally, this new enterprise will build on the wisdom of established senior researchers and capture the energy and imagination of their junior colleagues. Although senior researchers have job and career security that will permit exploration of new modes of working, junior researchers will need "protection" to experiment freely with new or emerging paradigms of what "counts" as educational research. Those concurrently pursuing tenure in academic departments of universities, for example, may perceive this work as high-risk. Negotiating entry to the educational system, building trusting relationships, co-developing frameworks and protocols, and co-interpreting data consume huge amounts of energy and time. And, because the period from startup to publication of results is typically very long, many researchers may find it difficult to publish the requisite number of research articles within the time dictated by tenure and promotion committees. In addition, it is difficult to find outlets for reports of long-term work on complex educational problems, although this may change over the coming years. We hope that this new research enterprise will encourage a new genre of research report, along with methodological and ethical criteria by which it should be judged.

As Problem-Solving Research and Development becomes more widely recognized and funded, we envision it becoming a practical alternative career path for top-quality researchers. Indeed, if increasing numbers of promising young researchers to choose the freedom and flexibility of a career path in this new field, academic departments (especially schools of education) may be challenged to become more relevant to the concerns of practice or risk losing their best researchers.

Needless to say, the attraction of this kind of work would be greatly enhanced by long-term stability in the funding stream to support the development of a vigorous field. The OERI could signal its commitment in other ways as well. For example, it could provide both pre- post-doctoral training grants as well as distinguished-educator fellowships for people interested in pursuing Problem-Solving Research and Development. We strongly recommend that OERI take active steps to include scholars of color in as many of these grants and fellowships as possible. It could also recruit senior, established researchers with inclinations and experience in this kind of work to advise and spearhead the creation of the initial hub-and-spoke federations.

Practitioners

We believe that many leading-edge practitioners will be captivated by the idea of working side by side with researchers to improve their own practice and to derive generalized understandings about how and why things work, understandings that can help others in different school settings. Like their researcher counterparts, the practitioners who apply for funding are likely to be in the vanguard of public education. Nevertheless, to be successful, this new enterprise will also need the cooperation of rank-and-file educators.

Developing their support may be an uphill battle. For a variety of reasons, including the divergent theories of action that often divide researchers and practitioners, the politicizing of education by local communities, and the instability of school administrations, introducing and sustaining innovation in public educational institutions is difficult. Good working relationships between educational practitioners and researchers are based on an investment of time in getting to know one another and on deep understandings of the culture of schooling in general, and the setting of the research in particular. For practitioners, having outsiders—even friendly advisers—in their school or classroom creates pressures and spawns anxieties regarding the manner in which and to whom their work will be exposed. Some teachers may already distrust universities and educational researchers as a result of past experiences in which they have felt ill-served.

Even when misgivings are not present, the worlds of practice and research, at least as traditionally conceived, operate under different incentive systems. Practitioners are expected to maintain an orderly, safe, and instructionally sound environment; typically, they are not rewarded for time and effort put into discussions with colleagues, personal reflection, or collaborations with professionals who are not members of their immediate school setting. It may be difficult, therefore, for teachers, principals, and others to justify the time devoted to Problem-Solving Research and Development.

Time is conceived very differently in the worlds of practice and research. Teachers and other working educators often need answers for their daily practice faster than researchers are able to provide them. Another concern for Problem-Solving Research and Development, then, will be balancing the sense of urgency in most districts/schools to find and implement solutions against the need of researchers to be thoughtful, well-founded, and reflective.

Despite these disincentives, we believe that many practitioners will choose to participate in Problem-Solving Research and Development, especially if other conditions are met. First, the work of the group must be focused on and perceived as making headway in solving a problem with which the practitioners are deeply concerned. Another incentive for teachers is the resources that frequently accompany participation in funded projects. Depending on the nature of the work, teachers, principals, and other professionals might receive computers or other technology, professional journals or books, instructional materials, money for substitute teachers, travel to professional meetings, university credits, or a variety of other benefits. Finally, practitioners who participate in this kind of invigorating professional experience benefit from the "sense of belonging" that comes from becoming a member of a professional community of practice. Developing a sense of identity as a contributing professional provides an unparalleled source of motivation and inspiration.

Incentives to Maintaining Research Priorities

Given the deep sense of obligation to educational practice and student learning outcomes that is likely to develop, and the sense of exhilaration that often accompanies on-the-ground problem solving, participants may fail to invest the necessary time and energy in research activities.

Therefore incentives for maintaining research priorities must be built into Problem-Solving Research and Development from the start.

Quality research demands time. Researchers and practitioners must have the opportunity to "touch base" at several points in the process of initiating, conducting, and interpreting the research. Therefore time must be set aside for researchers and practitioners jointly to identify topics, frameworks, and methods; to discuss the progress of data collection; and, finally, to analyze and reflect on emerging findings. In addition to the provision of joint meeting times, participants would also benefit from "sabbatical time" built into grants for research and writing activities.

Quality research and development work also demands a delicate balance between freedom and rigorous standards. Participants must have the flexibility to explore, reflect, and make mid-course corrections. This will involve making mistakes, recognizing and acknowledging them, resetting goals and timetables, and, at times, creating alliances with other projects working toward similar ends. The current manner in which the research and funding communities work—with emphasis on what each funder is underwriting and expects to have "delivered" under its auspices—works against supporting the long-term collaborative efforts we are recommending.

Even with the kind of freedom we envision as necessary, however, adherence to rigorous standards of methodology and standards of evidence, ideally created by a community of peers who conduct similar forms of research, will be needed. Problem-Solving Research and Development projects will need to build into their work the expectation of peer review and discussion of research results. In addition, a long-term system of disinterested third-party evaluation and analysis of Problem-Solving R&D projects and federations will be important to ensure that both the research and the practice goals of the new program are met.

II.7. Organizing to Commission, Support, and Carry Out Problem-Solving Research and Development

In earlier parts of this section, we have identified a number of qualities of the Problem-Solving R&D that we advocate.

- It is motivated by the desire to understand and solve important educational problems;
- It is co-developed by the research and practice communities, but with recognition of differences in expertise and authority. Joint development includes the definition of the problem, the strategies for attacking the problem, and the interpretation of the data and findings.
- It involves a long-term commitment toward constructing designs, testing them, revising and refining them, and retesting them in continuing refinement and improvement.

- It is conceived and carried out with a deep concern for producing principles, theories, materials, tools, and expertise that will "travel," as well as contributions to fundamental knowledge and understanding that will be of broad use to the research community. The central goal of the research and development is to help practitioners facing similar problems in different settings to attack and solve those problems.

Who Should Do Problem-Solving Research and Development?

In the immediate future, we do not believe that the OERI program managers should create and fund institutions. We have not developed a clear vision of what such institutions should look like, and, in any case, setting up institutions would distract researchers and practitioners from the problem-solving tasks that we advocate. Some programs we have cited as potential exemplars (e.g., Success for All, the Institute for Learning, and the Consortium Chicago School Research) had their origins in the academy and some in OERI's research centers (e.g., CREDE). As they have evolved, however, several found it necessary to find or create organizational homes whose mission and incentives more closely parallel their evolving needs. We have discussed many of the incentive problems above in Section II.6.

Some might argue that the Regional Labs or some research centers are natural homes for the activities we propose. A hub-and-spokes organization would be desirable for many research centers, and either class of institution is a potential performer of such work. Nevertheless, we do not believe that they have an inherent comparative advantage in doing the work. The labs have evolved as organizations that provide services, mostly in specified geographic regions. Although some have carried out activities with many of the attributes we have in mind, that is not their specialty. We feel there is general agreement that the missions and status of the labs have not permitted them to attract significant numbers of highly qualified researchers.

We feel that rather than create and support institutions, the government should fund projects that have promise, whatever the primary affiliations of their participants might be. Moreover, it will be important that the people who do Problem-Solving Research and Development represent the broad spectrum of researchers and working educators in our country today. As stated in the Introduction, a concern for diversity and for students at risk sits at the core of our beliefs regarding the kinds of problems that must be solved. Therefore it will be important to pull in a diversity of talent to serve on Problem-Solving Research and Development teams, including teachers, professional developers, and administrators as well as researchers. In order to meld the differing talents and views that we feel are necessary, the respondents to any solicitation for Problem-Solving Research and Development will likely be collaboratives of individuals and groups of researchers and practitioners. Experience suggests that these groupings will likely change significantly over time. In time, a new class of problem-solving institutions may emerge.

Problem-Solving Research and Development, as we have described it, also involves sustained and purposeful association of a number of different but related projects. This association should enrich and extend the activities of the individual projects and result in research and evaluation that lead to broader forms of understanding and that better inform potential users of the products of the Problem-Solving R&D effort. Achieving this goal will require assembling teams of researchers and practitioners at multiple sites and linking sites together in a hub-and-spokes federation. In our judgment, OERI must organize and manage these activities in ways that differ from recent practice.

As with any new venture, creating a hub-and-spokes model of Problem-Solving Research and Development will not be without risk. Of prime interest to us is that the field *learn from* its initial forays so that improvements and refinements can be made in subsequent rounds of funding and use. The panel strongly recommends that this initiative be mounted gradually and that significant resources be committed to continuing study, evaluation, and analysis of the initial set of hub-and-spokes projects that are funded. These resources should be devoted to increasing our understanding of how the hub-and-spokes model contributes to the cumulation of knowledge across sites, as well as to evaluations of outcomes and processes. A third and final object of study should be the management processes that are put into place to oversee this initiative, a topic to which we now turn.

Options for Organizing to Support Problem-Solving Research and Development

The proposed hub-and-spokes model described in this proposal will place substantial demands on program management. The first requirement is that the managers be able to provide a useful definition of a problem to be attacked and then to refine and publicize the definition of that problem as the research and development unfolds. The managers must also have the ability and skills necessary to recognize or to assemble and support effective research-and-development teams. They must be adept at supporting the sequential decision-making process that must accompany the evolution of a design and its translation into principles, materials, and skilled staff needed to enlist significant numbers of practitioners. Because we believe that both the research and the development will be significantly enhanced by the hub-and-spokes arrangement, the program managers should be able either to promote collaboration or perhaps even to perform the functions of a hub themselves. Finally, the managers must be able effectively to oversee and sustain projects and programs that involve significant funding. The examples of activities that we have used to guide our deliberations have all involved substantial levels of funding over five or more years.

Collectively, these requirements call for disciplined flexibility, ability to command the respect of the performers of the research and development, and leadership that fosters the type of team-based research and development we have described. The canons of research, practice, or assistance cannot completely dominate an effort, yet each project must be encouraged to move steadily toward useful findings, products, and services. Such movement usually requires encouragement and even pressure from outside the R&D project team. This is an important role for the program office.

Given the demands associated with overseeing this type of research and development, OERI will want to give considerable attention to deciding where to house the management of this new initiative. An argument can be made for commissioning, supporting, and carrying out this work in an institution that is outside the government. The procedural requirements that have evolved within governmental agencies to assure fairness limit the flexibility and decision making of program officials. Political pressures favor evenhanded and equal treatment, and the procedural difficulty in changing the direction of a program deters many government officials from even trying. These problems are inherent in any government bureaucracy. We propose, instead, contracting with a firm or institution to manage this initiative. The New American Schools Development Corporation is an example of the kind of firm we are thinking of, although it has not emphasized research to the degree we envision. We can also imagine creating a public corporation that is directly accountable to Congress and that carries out the classes of activities we propose.

We see several advantages to such arrangements. Such an institution would have management flexibility that is difficult to achieve in a bureaucracy governed by many pages of rules and regulations that have accumulated over the years. It could adapt its procedures to the needs of the Problem-Solving Research and Development programs themselves rather than forcing the programs to adjust to the department's procedures. It might be able to attract a caliber of staff that is hard to attract to government. It would not be as rigidly bound by the need to commit funding to grants or contracts in accordance with the government's fiscal year. The organization might actively seek to engage foundations in support of this work. It is possible that such an organization could develop the ability to perform some of the functions we have associated with the hub in earlier sections.

Against these benefits, one can array a number of potential problems. Most important, perhaps is the challenge of building in appropriate accountability for the expenditure of public funds. In addition, creating or fostering the evolution of a new institution would require significant effort. And contracting out the management of an exciting program such as we envision could make it difficult to attract high quality staff to OERI.

If the initiative is housed with OERI, the panel believes that the management responsibility for competitions and monitoring of Problem-Solving Research and Development efforts should be located at the highest possible bureaucratic level, with strong collaborative participation by members of the research and practitioner communities. We would prefer to see a program management office in the office of the Assistant Secretary for OERI and reporting directly to him. This organizational structure would allow the Assistant Secretary to exercise continuing direct oversight and, more important, to encourage the sort of flexibility and risk taking that this enterprise requires. The location of all the individual projects in a single program office would also contribute to developing the hub-and-spoke arrangement we advocate.

An alternative would be to locate the leadership of a hub-and-spokes activity in the OERI institute whose mission most clearly encompasses the problem addressed by the program. The advantage of such a location is that the programs might benefit from association with the research and development being carried out in other parts of the institute. There are a number of disadvantages, however, including the likelihood that many problem-solving efforts will cross the boundaries of the existing institutes and that the effort will be less able to attract the outstanding leaders and top-level support we feel it needs.

We would strongly oppose distributing individual projects (spokes) among the institutes and other organizational units in OERI. Not only would this structure lead to uneven direction, but it would also severely inhibit the collaboration we see as having great benefits in a hub-and-spokes design.

The panel did not study this management issue sufficiently to make a firm recommendation regarding the appropriate way in which to organize this effort. Nevertheless, our proposals require that important parts of the research community modify their traditional behaviors and incentives. Surely they would require the same of the government.

II.8. Relations with Research in the Basic and Applied Quadrants

We repeat that the NAE study group is *not* recommending that the activities we are calling Problem-Solving Research and Development should replace OERI's support for more traditional basic research to advance fundamental understanding of educational principles or applied research and development to improve educational resources and practices. Rather, this new direction of OERI-supported activity should be developed so that it is integrally connected to the more traditional activities of research and improvement. In Stokes's two-dimensional model, the conceptual basis for our recommendations, Problem-Solving Research and Development (which he called use-inspired basic research) is not a self-contained enterprise, carried out by a community separated from other communities of researchers and practitioners. As his diagram (figure 1 of the Executive Summary) indicates, use-inspired basic research contributes both to advances in fundamental understanding and to improved technologies and practices. It contributes to advances in fundamental understanding in conjunction with basic research, and it contributes to advances in technologies and practices in conjunction with applied research and development.

The contribution of Problem-Solving R&D to general explanatory principles should interact integrally with research conducted in the traditional research disciplines of the behavioral and social sciences, as well as with research on basic processes that is conducted in the field of education. We should strive to discover and formulate fundamental principles of learning, cognition, and social interaction that are as general and coherent as possible, so that the society's understanding of educational practices and its debates about alternative policies are based on sound and valid principles. We should apply concepts and principles developed in basic research that can suggest ways of approaching problems, and we should evaluate those concepts and principles in the light of experience in using them. Problems and questions that arise in Problem-Solving R&D should also be pursued in basic research, which may need to be conducted outside the settings of practical problem-solving.

Problem-Solving R&D also needs to interact integrally with what Stokes called Pure Applied Research, that is, with efforts that are aimed primarily at improving the effectiveness of educational systems. Indeed, this interaction is at the core of issues of "travel" that we discuss in Section II.4. The ideas and principles, the tools and defined processes, and the kinds of people that are developed to assist people in sites beyond those in the Problem-Solving R&D activities all embody the understandings that are achieved in those projects. They all need to be evaluated and understood in order to improve the effectiveness and utility of the programs and to feed back into the design of further Problem-Solving R&D.

III. CRITICAL TRANSITIONS IN THE LIVES OF LOW-INCOME STUDENTS

III.1. Background

All students make critical transitions as they move from family to school, from elementary to middle school to high school to college, and from school to work. They advance in knowledge, skills, and understanding of concepts and methods in the subject-matter domains of the school curriculum. Other important transitions involve changes in the ways children participate in social practices that are required for them to be legitimate and productive members of their classroom and school communities. Both of these aspects of transition are especially critical in the lives of low-income students.

Although a substantial literature points to the contextual basis of competence, many educational practitioners and researchers continue to treat the underachievement of students raised in poverty as a biologically or culturally determined trait. Members of the NAE study group believe this is a fundamental misconception. In our opinion, poverty should be viewed as part of the context of some people's lives, not as an essential trait or an immutable state. Furthermore, poverty is not just a context of the poor, it is also a circumstance that helps to make people poor. In consequence, too many of our citizens are not just "passing through" poverty—many remain in poverty, generation after generation.

Poverty is too prevalent in our society. Analyses of indicators by the United Nations reveal that poverty in America is a condition of life for many of our children. The number of hungry Americans (30 million) and the degree of income disparity in the U.S. (the richest 20% of Americans earn 8.9 times more than the poorest 20%)[45] are indicators that show that the challenge of accomplishing high achievement for low income students involves a large segment of our society.

The gap between the "haves" and the "have nots" is recapitulated in U.S. communities and affects both urban and rural schools. The proportion of the population living below the poverty threshold (defined as an annual income of $16,400 for a family of four and $12,802 for a family of three) was 13.3% in 1997. The poverty-level income is less than half of the 1997 median household income of $37,005. The poverty rates for Hispanics (27.1%) and African Americans (26.5%) are significantly higher than the rates for whites (11.0 %) and for Asians and Pacific Islanders (14.0%).[46]

Comparisons of US schooling with schooling in other societies show that we have made some transitions difficult that need not be, including, for example, sitting still for long hours, decoding by the end of first grade, and reading for comprehension and number facts by fourth grade. Japanese grade schools, for example, spend more than half of their days on physical activities and art. These transitions often harm low-income students because they require considerable early preparation.

Even though it is not necessary for students to display knowledge at required times in order to be good students months or even years later, our society's focus on early transitions has produced a machinery for differential diagnosis and institutional sorting. Students who do not pass successfully through these (and other) transition points are relegated to special education and remedial education programs where they learn to define themselves as inferior, as "dumber." The sorting and labeling affects low-income students disproportionately.

The first critical transition emerges from the neighborhood in which students and their families live. The socioeconomic circumstances of neighborhoods determine in large measure the quality of educational resources available to students. Both the subject-matter contents and the social arrangements of school learning are organized in ways that differentially favor some children, by providing better matches to knowledge and social practices that they bring to school.

The children who are favored in this way find it easier to become successful in their early schooling. Students attending schools in low-income neighborhoods have teachers with fewer formal qualifications, fewer facilities, and less rigorous curricula than students attending schools in wealthier neighborhoods.[47] The lack of resources, in turn, contributes to students' poor academic performance. Although these students find transitions into the school learning environment more difficult, fewer resources are generally made available to support their success.

The patterns of differential access *between* schools are recapitulated *within* schools. For all students to reach high achievement, schools need to support transitions from lower to higher levels of success by students whose academic performance is low. Students from low-income backgrounds are more likely to be placed in low-ability groups and low-track classes. Stratified tracking systems that segregate students in separate programs have been criticized as dysfunctional and undemocratic. Students placed in low tracks seldom catch up to their peers, seldom receive equivalent instruction or curriculum, and often suffer the stigma of negative labeling.[48]

When curriculum is highly stratified, the lowest tier of homogeneous groups fuses with special education. Special education becomes a dumping ground, the institutional site designated to absorb students who have fallen behind their age cohort. Like other types of homogeneous groups, special education classes are disproportionately composed of students from low-income and ethnic-, racial-, and linguistic-minority backgrounds.

Our report on critical transitions parses our recommendations for research into two main parts: (1) topics where current research findings can already support productive work in applied research, policy, and innovative practice, and (2) topics where there is strong potential for research to accomplish advances of importance to education policy and practice. Within each main topic, our recommendations focus on two themes: Teaching and Learning, and the Social Organization of

Learning. When we consider Teaching and Learning, we focus on research and improvement in the elementary domains of literacy, language learning, and mathematics. As we have mentioned, this focus should not be interpreted as indicating that we believe other curriculum areas are unimportant; rather, these topics illustrate the kinds of research and development needed throughout the curriculum, and the recommendations we present can be taken as examples of the general kind of program that should be developed in other curriculum topics and educational levels as well.

III.2. Current Research That Can Support Productive Work in Policy and Practice

Teaching and Learning

There is a body of clear research and good synthesis concerning literacy, language learning, and mathematics. The NAE study group believes the research debate in these areas is, for the most part, settled. In all three, however, there is no clear picture of what happens when people try to apply that knowledge in various contexts where children from low-income backgrounds are being taught.

Literacy. In the literacy case, the National Research Council/National Academy of Sciences (NRC/NAS) recently issued a significant synthesizing report on beginning reading.[49] Research has established the importance of early reading as a crucial first step in school success. The NRC/NAS report, ***Preventing Reading Difficulties in Young Children,*** is a large step forward in reviewing research on the components of effective early literacy programs. Now research is needed to analyze how these recommendations are or are not put into practice in K-3 programs and what factors lead to success or to failure.

Language Learning. The NRC has also provided a comprehensive synthesis of research on the education of linguistically and culturally diverse populations.[50] The NRC review of the growing and robust research literature indicates that certain attributes are important in educational success for students learning English. These include a supportive school-wide climate, strong school leadership, a customized learning environment, articulation and coordination within and between schools, use of native language and culture in instruction, a balanced curriculum that includes both basic and higher-order skills, explicit skills instruction, opportunities for student-directed instruction, use of instructional strategies that enhance understanding, opportunities for practice, systematic student assessment, staff development, and home and parent involvement.

English language learners (ELLs) tend to be new immigrants, who in turn often come from impoverished families. In 1990, 10 million low-income immigrant children, age 0-17, were readying themselves for US schools or were already attending them. In 2015, this number is projected to rise to 20 million.[51]

A special set of critical transitions face these students in our educational institutions. In addition to making the transition to a new language, English Language Learners must learn new identities and cultural practices. For example, the language that ELLs use at home or on the playground develops differently from the language they use in the classroom. This situation is exacerbated by the fact that immigrant students arrive in the US at all ages, levels of education, and levels of literacy. Elementary schools have difficulty meeting the cultural and linguistic needs of new immigrants and English Language Learners. To make matters worse, middle schools, high schools, and colleges are even less well equipped to meet them.

Important transition points in English language learning include: (1) the ***transition from oral proficiency in students' first language to oral proficiency in their second language***, (2) the ***transition from oral language to literacy***, and (3) the ***transition into "academic discourse"*** (when a student engages written material in math, history, science, social studies, etc., and uses the vocabulary and conventions of these disciplines in discourse).

Particularly significant for future research, given the linguistic and cultural diversity of our schools and the diversity of students' previous educational experience and present social circumstances, are answers to two strategic questions: What specific educational interventions work well for specific populations of English Language Learners? What are the short-term and long-term academic and non-academic effects of these interventions? A related and short-term researchable topic of significance in a new era of standards-based accountability systems is the academic assessment of non-English speaking students. The competence of English Language Learning is simply not measured accurately by current techniques of assessment.

Mathematics. In the case of mathematics, an ambitious framework for educational practice has been developed by the National Council of Teachers of Mathematics.[52] Recently, sponsored by the National Science Foundation and other agencies, several mathematics curricula have been developed to provide materials for teachers and schools that choose to change their mathematics teaching in the direction that the NCTM *Standards* and others have advocated.[53] It is important that the effects of these standards and the effectiveness of these curricula for teaching all students, especially low-income students, be understood.

Research in mathematics education and cognitive science has identified conceptual transitions that are crucial for students learning mathematics, a course of study foundational to all students' academic careers. One critical transition in mathematics is understanding ***scale and order***; students first need to gain basic fluency with small numbers and their relations. A second concerns ***symbols;*** students need to know what it means to represent mathematical knowledge in formal terms.

Another important conceptual understanding concerns the shift from *additive to multiplicative functions*, that is, the shift from single quantities to the relations among quantities. A fourth concerns learning that mathematics is a *formal, internally consistent representational system.*

As we discuss in Section IV, OERI should support research to evaluate and understand the types of teaching methods used as these standards are adopted. We particularly need research that identifies how teachers can develop understandings and capabilities that support their teaching of critical mathematical understanding for all students, and what is impeding the implementation of those curricula, especially in schools with significant numbers of low-income children.

The courses taught in high-poverty schools are often less demanding than those offered in high-income schools. There is a danger that this discrepancy could be increased if the ambitious standards of educational reform, such as those advocated in the NCTM *Standards*, are adopted only in schools for children who are already relatively advantaged, or if they are imposed on schools in which the resources needed for their successful adoption are not available.[54]

Researchers are concerned by this possibility, and it has been investigated specifically in the QUASAR project, funded by the Ford Foundation.[55] Results of this research-and-development project show that ambitious curricula that emphasize students' conceptual growth in mathematics can be developed successfully in schools that serve low-income children. The results also show that success requires support by the school system and its administrators, allocation of adequate resources, and commitment by teachers to develop their teaching practices. It will be important for OERI to encourage and support a significant research effort to build on the important results of the QUASAR project and other research that has begun to examine the conditions in which ambitious curricular reform can succeed in schools that serve low-income children.

Social Organization of Learning

Many programs designed to encourage meaningful learning by all students, but especially low-income children, emphasize different ways in which students participate in the activities through which they learn.[56] These programs differ from those of traditional didactic learning and teaching in their requirements for student participation and new demands on teachers. Research has shown that students in these programs can benefit from participating more actively in formulating and evaluating questions, problems, examples, conclusions, explanations, and arguments, rather than limiting their learning activity to learning to recite the accepted answers to other people's questions and the accepted explanations that teachers and textbooks present. Many teachers will have to alter their methods to include such practices.

At the same time, concerns have been expressed[57] that requirements to participate actively in open-ended discourse may do more harm than good for some students, especially those whose cultural backgrounds do not include as much of that kind of participation as other students bring to school. Research is needed to disaggregate the benefits and disadvantages of various ways of organizing classroom discourse, and to teach educators how these practices can be carried out to the benefit of all children. There should be projects in which resources are developed to help teachers learn to conduct classroom activities in ways that are beneficial, especially for low-income students, as we discuss in Section III.

III.3. Topics of Needed Research With Potential for Advances in Policy and Practice

The topics we discuss in this section involve important issues for educational policy and practice, but in the judgment of the NAE study group, our current knowledge and understanding are not as far along as those we discussed in Section II.2. For these topics, we recommend a high priority for research that would provide fundamental understanding. We emphasize that activities involving development of educational programs need not wait for this research to be completed, if the development is carried out in projects that include fundamental research along with development and evaluation. Section IV of this report focuses on the need to build capacity for that kind of project.

Teaching and Learning

Developing Competence in Complex Reading Tasks. Much is known about getting children started in reading. But less is known about what competencies and programs help children to succeed beyond third grade, which is a critical transition because literacy texts and tasks become increasingly complex at that point. Even children who have made a good start in reading will not automatically become successful readers later in school, for all the reasons that the expression "critical transitions" indexes.[58]

Another candidate for research synthesis is in this area of learning to read complex texts: interpretation of literature and reading content area materials, particularly science and abstract representations. Our lack of information is compounded when the students in question are bilingual or bidialectal. OERI could establish programs of research focused on these higher-level reading capabilities, leading to development of programs that capitalize on students' diverse cultural backgrounds in their learning.

The Need to Focus on Writing. For the most part, the study of literacy focuses largely on reading. We feel we should also attend to writing. Writing, more than any other curriculum area, is notable for grass-roots/bottom-up enterprises (e.g., the Bay Area Writing Project, which has developed into the National Writing Project). There are highly influential, single-author books by teachers or researchers describing single classrooms. One of the most influential is at the middle school level,[59] where research findings do not have much to say when compared with, say, elementary school. But many of those books come out of programs where diversity of students is lacking—although see Dyson.[60] The writing practices of children from low-income backgrounds are not adequately studied;[61] nor is much said about the heterogeneity of children in schools. Studying a wider spectrum of children in more varied environments might give us new ideas for teaching writing.

Mathematics. Substantial numbers of students, especially those from low-income families, are lost at points of difficulty involving (1) the movement into basic numerical operations and fluency with basic arithmetic representations; (2) the transition from additive to multiplicative reasoning; (3) the understanding of formal representations, especially in algebra; and (4) the understanding that mathematics is an internally consistent system and that one can reason within the system, including both informal argumentation and formal proof. A synthesis of research on these transitions would move that research area forward.

Students attending schools in low-income neighborhoods are seldom explicitly taught the principles associated with these conceptual understandings. They remain implicit, to be inferred or understood tacitly by students who manage to "see through" the surface structures of procedures that are the main emphasis of daily instruction and tests. This practice especially harms students raised in poverty, because they are much more likely to be assigned teachers with less formal preparation in mathematics. If they don't learn math the first time, they are simply re-taught the same problems in the same way.

A body of clear research findings shows that people, including children, have significant abilities to understand and reason mathematically, albeit informally, in many everyday and work activities.[62] Research is needed to study the pros and cons, the benefits and problems, when teachers use students' background knowledge as an organizing base for mathematics curricula. How does the use of students' knowledge aid student learning? Does the appropriation of students' knowledge lead to problems in the development of students' understanding of mathematics as a cohesive system?

Finally, a synthesis is needed of the research that explores ideas that would undermine the current lockstep sequencing of mathematics. For example, some researchers are exploring programs that introduce many mathematical principles earlier in the curriculum than they now appear. These possibilities deserve systematic cataloguing, especially for the prospect of broadening the population of students who succeed at what we now see as critical transitional boundaries.

Adult Learning. New immigrants and low-income students often use adult education centers and community colleges to improve their education, to learn English, and to become literate. That is, these institutions make important contributions to the democratic function of education that is critical for integration into our society.

Between instruction in community colleges and adult learning centers on the one hand, and the demands for literacy and learning in the workplace on the other hand, however, is a large gap.[63] There is evidence that remedial instruction for low-achieving students is being replaced by rich and rigorous curricula, high standards, and additional academic and social supports in some elementary and high schools. This is less likely to happen in community colleges, however. Instruction on the academic tracks that are intended to transfer to 4-year colleges is often dominated by lectures, whereas instruction in "life-long learning" programs is more likely to use cooperative groups, manipulative materials, and other engaging techniques. Literacy instruction for low-income students and English Language Learners in community colleges and adult learning centers is often, unfortunately, still treated as remediation.

From School to Work and Work to School. We have much to learn about the education of low-income students from the way in which thinking and literacy are employed at work and the way in which people learn on the job. In calling attention to cognition, literacy, and learning on the job, we do not want to romanticize the workplace. We recognize that much of blue collar, white collar, and pink collar work is dreary, repetitive, and even exploitative. With this understanding in mind, we briefly summarize research that has looked closely at the day-to-day practices of people as they "think at work."[64]

Close observations of people in occupations as diverse as warehousing and high technology show that they employ many different representational systems and move expertly between them. Literacy in the workplace is embedded in continuing activities, is collaborative, is project-based, is performative, and is evaluated for its usefulness. Projects are often presented in multimedia formats. When workers are solving work-related problems on the shop floor, differences in age, expertise, gender, and ethnicity are often treated as a resource, not a liability. Workers interrupt work to solve problems about work. Front-line workers, supervisors, and engineers came together to solve problems, by talking through the issues and consulting documentation. Reflection on practice is a routine part of work.

This research demonstrates that the students for whom schools typically have low academic expectations do in fact display considerable competence on the job. If we better understood the organization and use of this knowledge, we could organize the schooling of low-income students more effectively.

Social Organization of Learning

Learning Out of School. The activities of children after school and out of school—in the neighborhood, at work, in youth organizations, in after-school clubs, in the home—are often neglected topics of investigation. This myopia limits our knowledge about low-income students because the learning that often matters most to them takes place outside of school, in the "institutional gap" between the family, school and other formal institutions.

Low-income students who participate in the most effective youth organizations, for instance, engage in management, security, construction, and financial work.[65] Literacy and learning are pervasive in youth organizations and after-school clubs, although they are often hard to find because they look different from the literacy and learning we see in school. They occur in a community of practice, are collaborative, and produce demonstrations or exhibitions as results.

Furthermore, some low-income, recent immigrant, ethnic minority, and ELL students develop and maintain multiple identities—a community identity in the neighborhood and an academic identity in school.[66] But it is more likely that the identities that low-income students develop do not have exchange value in formal educational settings because they are not well articulated with each other.

These findings about learning outside of school have implications for the social organization of education within schools. They imply that placing young people in low surveillance, project-oriented environments, with productive and meaningful engagement for high performance, with expert guides helping direct practice, and with authentic evaluation at a particular deadline by outside experts can make their competence visible.

An important concern involves learning preparedness, which means not only coming to school prepared to learn on the first day of kindergarten but coming to school prepared to learn every day and every year. We know that children from low-income backgrounds and children from more affluent backgrounds have quite different experiences during school vacations. As a result, low-income students lose more of their learning during the summer months.[67]

Research on youth organizations,[68] after-school clubs,[69] and authentic learning environments[70] describes programs that capitalize on and further develop competencies of children from low-income backgrounds. Many of these abilities are not developed or even recognized in schools. Children from impoverished backgrounds display competence out of school that is often superior to the competence they display in school because families, youth organizations, and clubs treat young people as productive resources, community assets, and knowledgeable people, not as damaged goods or deficient cultural participants.

Researchers should work with schools to organize contexts for educators to discover and make institutional use of the competence that low-income students display out of school. They could design and test different models of after-school and summer programs to see what would best motivate, engage, and benefit children from low-income backgrounds. In making this recommendation we are ***not*** proposing that out-of-school learning environments should be organized to mimic learning environments within schools. Students living in poverty will not benefit if pedagogy misapplied in one context is misapplied in another.

The Academic Benefits of Heterogeneity and Diversity. As with literacy, language learning, and mathematics, clear research and good syntheses demonstrate the harmful outcomes of educational practices that sort and stratify students disproportionately according to their background characteristics (race, ethnicity, gender, parents' income).[71] Educational practices such as retention, pull-out remediation programs, tracking, and segregated special education have enormous negative effects on the lives of low-income students. Because low-income students are disproportionately represented in such programs, they seldom receive curriculum and instruction equivalent to those of their more privileged peers. This uneven distribution of opportunities to learn is manifest not only in structural arrangements, but in cultural conceptions of race, ability, and intelligence and in the political conditions that influence decisions about how resources and opportunities are allocated to various groups of students.

A number of studies independently support the idea that heterogeneity and diversity are beneficial to the social ideals of a democratic society. They suggest that academically demanding, heterogeneous grouping helps students who have previously been placed in low-track homogeneous groups. Because these studies have been conducted with diverse populations, at different levels of the educational system, and often with different methods, a careful synthesis is needed to identify the common principles and the conditions under which heterogeneous grouping is a successful educational practice.

In addition to this synthesis of common principles, there is a need for research on diversity as an instructional resource. Though there are ***social*** benefits to a diverse instructional setting, an important area of inquiry is whether there are ***academic*** benefits to classroom diversity. In short, does diversity improve subject-matter learning?

Likewise, there is a considerable body of evidence to show that heterogeneous groups are beneficial for previously low-achieving students.[72] These findings provide a policy rationale for offering students from low-income backgrounds access to high-track instruction, such as college prep, honors, gifted, and seminar programs. Such efforts would run counter to the view, prevalent in some discussions, that a concerted effort needs to be made to eliminate so-called social promotions. OERI should encourage and support a substantial program of research to understand the effects of requirements to retain students on teaching and student learning, and to identify and analyze programs that support learning by all students when they all progress normally through grade levels, with provisions other than retention made for the known variation in rates of academic progress by individual students.

Considerably less evidence shows the benefits of heterogeneous grouping for high-achieving students. Therefore, a vital research question is: Do *all* students—previously low-achieving as well as previously high-achieving students—benefit from placement in heterogeneous groups? Do students from white, middle-income families as well as students from low-income, ethnic and linguistic minority backgrounds benefit from diverse learning settings? Because of the paucity of information on this topic, we need to examine the outcomes for high-achieving students as well as the outcomes for previously low-achieving students in the same heterogeneous groups. Consistent with our conviction that education serves democratic as well as economic goals, we recommend that research should examine psycho-social outcomes (such as an increased appreciation for difference) as well as academic outcomes (such as improved performance).

The Generative Processes of Heterogeneous Grouping. Research has shown that there are beneficial *outcomes* of heterogeneous grouping, but much less is known about the *processes* that contribute to beneficial outcomes. In particular, we need to develop a more complete inventory of knowledge about effective practices for teaching academically challenging curricula in heterogeneous groups. We also need research to learn more about the types of teaching practices that are effective in diverse classrooms and the types of school organization that support learning in diverse environments.

Students transferring into academically demanding courses of study need academic supports to help them make the transition. Homogeneous grouping creates cumulative handicaps for children in low academic tracks. The longer students remain in low-track classes, the further they fall behind their peers. Offering all students an academically challenging curriculum presents difficulties because of the range in incoming student achievement. For example, requiring that all students take Algebra I will present strong skill-based challenges for students transferring in from general, remedial, or business math. By contrast, students from high tracks most likely will enter a course such as algebra with the skills to meet the academic demands.

Programs that place previously low-achieving students in rigorous courses of study accompanied by systems of social and academic support show promise for improving the academic achievement of low-income students. *Puente* and AVID are examples of such programs.[73] They establish an "existence proof" that previously low-achieving students can succeed in demanding courses of study. We need more systematic information about the *processes* and *principles* that make such programs successful.

More specifically, what are some of the teaching and organizational practices that facilitate previously low-achieving students' success in academically demanding learning environments?

Some possible areas of inquiry are cross-age tutoring, the homeroom, the school-based building of social and cultural capital, the productive use of students' "funds of knowledge," and exposing the hidden curriculum of the school.[74]

Practitioners and researchers now need to collaborate to develop alternative strategies to promote the cognitive and social development of low-income students. Projects that combine programmatic innovations with research that examines the processes of learning in heterogeneously grouped learning environments can be especially valuable targets of the kind of problem-solving basic research that is recommended in Section II of this report.

A Special Emphasis on Middle School, High School, and Community College. Most of the research on heterogeneous grouping has been conducted in elementary schools. We need research that concentrates on effective pedagogical practices in middle schools, high schools, and community colleges. A concentration on community college is particularly important because of its special role in the lives of new immigrants, low-income students, and English Language Learners. The community college connects these groups of students to the democratic concerns of society and gives them the tools they need for economic success.

The education that new immigrants and low-income students receive in community colleges and adult learning centers helps them take a first step, but seldom many steps, up the ladder of social and economic mobility. We need to understand why the transition from 2-year to 4-year institutions does not produce more extensive social mobility. This investigation will be valuable if it does not just focus on the presumed limitations of 2-year institutions but turns attention to the institutional arrangements and academic demands of 4-year institutions as they relate to the 2-year and K-12 sectors. For example, the college entrance requirements that often drive the organization of the K-12 curriculum invite special attention.

This line of research is also important because the programs that "untrack" previously low-achieving students do help them improve academically, but they do not send them to the head of the class. For example, the very successful *Puente* and AVID programs increase the number of Latino students attending the California State University, but they do not increase significantly the number of Latino students attending the University of California (which has more rigorous entrance requirements). Likewise, these programs increase the number of Latino students taking AP courses, but they do not increase the number of Latino students passing the AP exam. These findings encourage research to determine which teaching and organizational arrangements significantly improve the academic performance of low-income students once schools have begun to undo their tracking systems.

Community Building. The mobilization of parent groups against educational reforms such as integration (particularly busing) and detracking (the elimination of homogeneous grouping at the secondary school level) suggests that school reform is more than just a technical challenge.[75] School reform also requires political and cultural change at the school and in the wider community.

We need to understand the interplay between the technical, cultural, and political dimensions of schooling. We know that educational professionals at every level of the school system—classroom teachers, principals, superintendents—need to support an academically rigorous curriculum for all students. But the conditions and processes that lead educators to alter fundamental cultural norms about ability, learning as individual "acquisition," teaching as transmission, and achievement as individualistic and competitive are not known. How can teachers sustain new norms, and what effect do such shifts have on access?

Likewise, we know that educators need to cooperate with families and community groups to sustain reform efforts. This basic observation leads to a more difficult research question: How can education professionals build these all-important alliances? The possibility of divisive cleavages among parent groups based on socioeconomic status requires research attention. How can schools that work to achieve equal educational opportunity retain children from families used to having a competitive advantage?

These issues also lead to consideration of how research on the education of low-income children can be used to strengthen the community and the whole society. It is not enough to change or improve individuals. We also need to change and improve communities. If we change individuals only, their motivation may be to "get out" of "bad" communities. It does not benefit society as a whole if we force people to make a choice between leaving their communities and staying in them in order to be successful. If, on the other hand, we improve communities, it matters less whether particular individuals leave. Shifting our thinking beyond improving individuals and to strengthening communities requires a very different research orientation. It requires looking at cognitive and social outcomes for the community and society as well as for the individual.

III.4. Summary

Our society is in a critical transition in our thinking about the very meaning of public education. On the one hand, we note an increasing recognition that students are a focal point of complex social and cultural forces, not a bundle of psychological states and traits. On the other hand, calls to privatize education through vouchers and some charter school proposals threaten the idea that public schools are a social good available to all students regardless of their parents' ability or willingness to pay.

These issues create both challenges and opportunities for research on the education of low-income students and the transformation of research knowledge into usable educational practice. In this report we have said that the lives of low-income students are marked by critical transitions. Within schools, these include the transitions between courses of study or "tracks." Outside of school, these include the transitions between school, the family, work, and community organizations.

We have suggested that the research community has accumulated a sufficient body of knowledge regarding some issues in the areas of mathematics, literacy, language development, and the social organization of instruction. Therefore OERI can focus attention on developing appropriate strategies to help practitioners apply that knowledge in various contexts where children from low-income backgrounds are taught.

We identified a second class of topics where there is strong potential for research advances of importance to educational policy and practice. These topics include the study of complex reading tasks (especially above grade 3), a special emphasis on writing, and more successful learning of mathematics with conceptual understanding. These topics also include learning in the institutional gap between schooling and other organizations, the academic and social benefits of academically challenging courses accompanied by social scaffolding, and language and learning in middle school, high school, and community college. Finally, we must learn how to build strong communities.

Attending to these research agendas will help Americans to build strong democratic conventions and institutions and prepare low-income students for an increasingly competitive economic world.

IV. TEACHERS' PROFESSIONAL DEVELOPMENT

IV.1. The Panel's Mission

The work of this panel was conducted under the assumption that teachers' professional development is related to reaching the goal of high achievement for all students. The panel was concerned particularly with producing knowledge about the connection between professional development and improving education for currently underserved populations. Students living in poverty and ethnic minorities have been historically underserved by American educational institutions and are an increasingly large proportion of the student population. No one doubts that teachers will have much to learn in the years to come in order to be successful in helping all students reach high levels of achievement.

Researchers and policy makers have learned from our previous lack of attention to teaching and teacher learning. Hence recent federal, state, and private efforts to improve education are placing a much greater emphasis on investing in professional development[76] for teachers. We are politically and economically poised to invest in teacher development in ways unlike previous reforms. But despite the recent interest, our understanding of professional development and factors that affect what teachers learn and do is uneven and underdeveloped. Therefore our knowledge of the processes whereby it can improve education is weak. Though researchers have learned a good deal in the past several decades, much more remains to be learned about the practice of teaching itself and what it takes to teach, as well as the kinds of experiences that enable teachers to develop the abilities, dispositions, knowledge, and skills to do that work.

Given the current state of American education, the assumption that teachers' professional development is related to reaching the unattained goal of high achievement for all students implies a related pair of assertions, illustrated in figure 3:

A. that a change in teaching practice can cause a positive change in student learning, especially for those students who do not now reach high achievement, and

B. that teachers' professional development can cause such a change in teaching practice.

Accordingly, the study group's report concerning teachers' professional development is organized around two key issues:

- how teachers effect student learning
- effects of teachers' professional development on teaching.

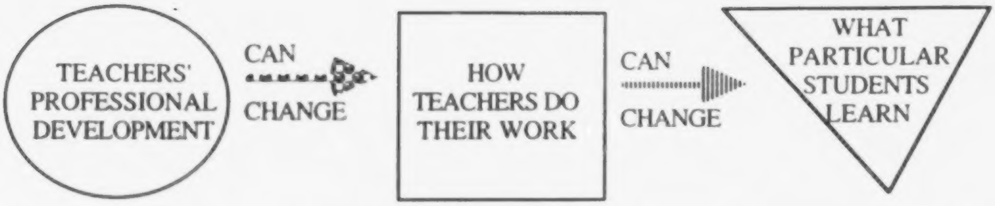
TEACHERS' PROFESSIONAL DEVELOPMENT
CAN
CHANGE
HOW TEACHERS DO THEIR WORK
CAN
CHANGE
WHAT PARTICULAR STUDENTS LEARN

figure 1

IV.2. What We Know and What We Need to Know

This section reviews research that has been done on each of the relevant issues and analyzes where our knowledge breaks down, particularly with regards to connecting teachers' professional development to working toward the goal of high achievement for all students, without regard to ethnicity, gender, language, and social class. There is no neat package of research that bears on the topic of this panel. We have sought to become broadly informed about research on the relevant issues and we have organized what we have learned in this section in terms of the effects of teaching on learning, teachers' knowledge and skill, teachers' opportunities to learn, and teaching as professional practice. In the next section, we cull from this diverse set of themes to delineate the research agenda that flows from considering the intersections and gaps in what we know, and what we need to know if teachers are to develop in ways that broadly improve learning for all students.

We first examine what we know about the conditions under which a change in teaching practice can cause a change in student learning. Although we recognize a considerable body of research on "teacher effects," we note that this research has not been easy to translate into strategies for making all teachers effective with all students. Some commentators attribute this "translation problem" to a lack of attention to teachers' intentions as well as to their knowledge and skill. We also observe that this research has been weak in recognizing and describing variations in teaching activities in relation to variations in the characteristics of the particular setting in which teaching occurs, i.e. who the students are and what it is those students are to learn. We look briefly at research on teacher knowledge and skill, focusing on how professional development responded to earlier research on instructional practice and examining work on teacher qualifications, particularly as it pertains to the problem of providing competent teachers for underserved populations.

We turn next to research on school context for what it has to offer to our understanding of teachers' opportunities to learn. This research is the most comprehensively related to the issues raised by our panel's charge and leads us to adopt the theoretical framework of "learning in and from practice" for situating our recommendations. We then move to identifying the research problems arising from the assertion that teacher development can cause a change in teaching practice. We investigate what we know about teachers' professional learning as the individual and collective improvement of teaching practice.

As we try to maintain the connection between teacher learning and student learning. we observe that research on teacher learning has focused primarily on the acquisition of skills, dispositions, and knowledge with little attention to how these play out in what teachers do or in what students learn. We adopt the perspective that teaching is a complex practice and consider the continuous learning of teaching across the teacher's career as an integral part of that practice. We review what is known about learning in practices such as teaching, with particular attention to the role that professional communities play in such learning, since it is in such communities that norms of practice are established.

How Teachers Effect Student Learning

Research that links teaching with learning is the ultimate goal of what teachers do and the development of the profession.

- What do we know about the connections between what teachers do and what students learn?
- Where does that knowledge break down in decoupling school success from race, ethnicity, gender, and social class?

The Effect of Variations in Instruction. Researchers have identified some unusually effective teachers, as judged by their students' gains on standardized tests, and noticed that their practice seemed very different from their less effective peers'. More effective teachers plan lessons carefully, select appropriate materials, make their goals clear to students, maintain a brisk pace in lessons, check students' work regularly, and teach material again when students have trouble learning.[77] Teachers of this sort have coherent strategies for instruction and deploy lessons, books, and other resources in ways consistent with the strategies. They believe that their students can learn and that they have a responsibility to help. They have definite objectives and organize instruction to achieve them. Though often traditional and didactic, these teachers' lessons are well thought-out, well organized, and appropriately paced. Typically these teachers use conventional tests and texts as part of a well-crafted strategy to improve children's learning.

Less successful teachers do not have coherent strategies for instruction and deploy resources in scattered and inconsistent ways.[78] They have vague or non-academic objectives, and their lessons are disorganized and not well thought-out. Classroom work typically is badly paced, and teachers do not regularly check to see how students are doing—and even if they do check they do not make many mid-course corrections to accommodate students' responses. Teachers of this sort do not exert themselves to make educationally fruitful connections with students; many act as though they believe that their responsibility is only to "present the material" and let students get it if they can. When such teachers work with children from disadvantaged circumstances, they often act as though students can handle only watered-down instruction.

Others have looked at how time spent on instruction affects learning.[79] Considered in isolation, time is not a potent or consistent influence on learning. One reason is that measuring the time that teachers spend teaching something does not necessarily reflect the time that students spend studying it. The important point concerns the relations among how teachers organize instruction, what tasks students perform, and actual learning. What counts for learning is how teachers and students fill time. Some researchers have objected to some of this work, partly on the grounds that the criterion of effectiveness was standardized test performance. Though such tests do offer a limited range of assessment possibilities, there is increasing evidence that the tests measure things that predict students' success in school. No less important, research can systematically connect professional practice with students' learning, and such connections are crucial to the improvement both of practice and learning. It is possible to define and measure teaching and learning tasks, to observe the extent to which they are related, and to probe their effects on academic learning. Such knowledge of effective practice is in principle be an important element in teacher development.

Teachers' Knowledge and Skill. One outcome of research on effective teaching (unintended by those who conducted it) was for reformers to assume that if teachers did not teach effectively, it was because they did not know what was effective. Knowledge for teaching was equated with knowledge of research findings, and teacher learning was considered a "skill transfer problem."

Both research on teacher learning and teacher development practice were dominated by a skill training paradigm for many years. Coaching emphasized expert demonstrations and feedback on teacher practice. Later developments in the model—especially those centered on peer coaching rather than expert coaching—placed greater emphasis on teachers' opportunity to engage in problem solving and to talk at length about their interpretation of practice. The eventual introduction of "cognitive coaching" as a term may reflect the growing influence of research on teachers' thinking, beliefs, and judgments.

A very different approach to research on teachers' knowledge and skill appears in the literature on teacher qualifications. Knowledge was seen as formal education: how many courses have been taken in what areas? Standards for what teachers need to know and be able to do to enter teaching and to stay in the profession are inconsistent across states and districts. Hundreds of studies have shown that "fully prepared" teachers are more effective than those who are unqualified.[80] Schools that serve the poor and students of color have a disproportionate number of "unqualified" teachers.

A third approach to research on teachers' knowledge and skill has come with a recent wave of attention to teachers' "subject matter knowledge" or lack thereof. Central to the conception of teaching as a practice that requires knowledge of subject, instructional method, students, and how they learn is the notion of pedagogical content knowledge—the specific knowledge of how to teach particular subjects. Research on the acquisition of subject teaching knowledge has developed rapidly. Studies of what teachers do and do not know about mathematics, history, science, and the like have been justified on the assumption that "you cannot teach what you do not know." But none of these studies looks either at what teachers do differently depending on variations in their subject matter knowledge, nor on whether students' learning is indeed affected.

Intentionality. Relating research on teacher effectiveness and attention to teachers' knowledge and skill neglects the crucial gap between ***knowing what to do*** and ***doing it.*** A distinction between knowledge of what makes teachers effective and knowledge of how effective teachers teach is useful.[81] A recent line of work on teacher effectiveness focuses specifically on teachers who are successful with African-American children; it found that they have many of the same qualities as the successful teachers in the older "teacher effects" studies and they have the will to succeed with African-American students.[82] Additionally, culturally relevant teaching methods challenge students intellectually by teaching to the highest standards, not the lowest common denominator; provide instructional "scaffolding" so that students can move from what they know to what they need to know; make instruction the foremost activity in the classroom; and are constructed out of thorough knowledge of both the students and the subject matter. These teachers teach in a way that intentionally includes all students. This inclusiveness requires us to consider teaching as requiring more than a bundle of technical skills—it also demands moral commitment and the ability to act on that commitment.

Differentiating Successful Teacher Practices According to What Students Are to Learn. Teaching different subjects (like mathematics and social studies) has some elements in common, but it also has significant differences, and the differences become more evident as the content becomes more complex.[83] What teachers need to do also differs depending on the nature of the learning goals for their students within a particular subject. If students are to learn to repeat what they have read or heard, teaching is one kind of work. If they are to learn to read a text and use what they have read to solve a problem, teaching is another kind of work. Teachers work in a particular institutional context; they must reference their ambitions for students to the district curriculum and other elements in the environment. They must think and act strategically as they face competing priorities and demands in their efforts to engage students with a task. Thinking about where students might go in an academic domain involves gathering evidence about where students are. Weighing where students are involves understanding the variety of ways in which students may display knowledge.

We have come to expect all students to learn to more rigorous academic standards than have ever been set in the history of this country.[84] Teaching K-12 students powerful academic skills, knowledge, and dispositions, and teaching them so that all students are able to perform to uniformly high standards, is complicated work. Even when teachers have high levels of appropriate knowledge, it is hard to teach classrooms full of students, especially when the students do not come to school already disposed toward the kinds of intellectual work that school requires. Existing research on the effects of teaching practices has little to say about the particular student learning goal of "achieving high literacy." The standardized tests used as a measure of learning were not designed to measure the kinds of problem solving and communication skills that we now expect students to acquire. But even more important, given the purpose of this report, is that none of this research, even the most recent work on teacher intentionality, gives us much insight into what it takes *to do* effective and successful teaching with diverse populations of students or how teachers will acquire what it takes to do it.

Contextual Factors and the Effects of Teaching. Moving out from the practices of individual teachers to the settings in which they teach, we find additional research that tells us "what matters" to student success. It is relevant here because it attends not only to what teachers know and do as resources in producing student learning, but to the context in which they work. Much of this work has compared schools. Some schools have produced unusually large achievement gains, and it would be useful to identify what distinguishes them from run-of-the-mill schools for what we can learn about contexts for the improvement of teaching. Researchers in this tradition have tried to identify how the context of teaching might change teaching practices in ways that affect student learning.

We are beginning to understand that what matters is how teachers *make use* of contextual factors to support their efforts to improve their practice. This is a major step beyond seeing the context as an independent element that either supports or interferes with student success regardless of what teachers do.

Faculty in unusually effective schools share a vision of the purposes of instruction, agree that their school's purpose is to promote students' learning, and believe that they are responsible for helping students to learn. Principals offer strong leadership, and teachers have a strong commitment to students' academic success. They also have the ability to monitor students' learning.[85]

Critics have pointed out crucial problems with this line of work, including inter-annual variation in effectiveness as well as problems in reasoning from schools with unusually high performance to more ordinary schools. Studies have focused almost exclusively on elementary schools and did not take account of the organizational differences between primary and secondary schools.[86]

Nevertheless, some characteristics that distinguish effective schools have been identified. In one study, more effective high schools were more likely to have teachers who shared a commitment to their students' academic success and believed that they had an obligation to help students do so.[87] More effective high schools are likely to be smaller and small schools seem to increase the probability that academic communities with high expectations for all students can be constructed.[88] Effective high schools establish and maintain communities in which students and teachers take responsibility for each other, academically and socially. Students are likely to study the same curriculum, for there is little curriculum tracking in small schools. Students in such schools had higher achievement, and it is especially noteworthy that achievement differences between advantaged and disadvantaged students decreased over the high school years. Typical secondary schools are much more fragmented and anomic. Teachers, staff, and students in these weaker schools share no common vision of instructional purposes, no common commitment to students' success, and no common curriculum. Teachers and students have little contact outside of class, the schools have low morale, and achievement differences between advantaged and disadvantaged students increase over the high school years.

As well as school size, class size seems to affect learning. Evidence suggests that 25-30% reductions in class size produce substantial gains in student learning growth, other things being equal.[89] The effects of class size could be produced in two somewhat different ways. Students could benefit because smaller classes provide teachers with better opportunities to use their existing knowledge and skills—more time to spend with each student, more opportunities to read students' work, more time to prepare, and so on. Smaller classes could also enable teachers to learn additional knowledge and skills on their own, which would enable them to further improve their teaching and their students' learning. Teachers could turn things that they already knew to better advantage, rather than learning dramatically new instructional approaches.

These speculations about school size and class size as contexts not only for student learning but for teacher learning suggest that the work of teaching is made more or less difficult by the resources that are available in the context. Instead of changing what teachers know, we might try to understand what resources could be made available for their learning to improve their practice. Although research on school size and class size begins to identify what some of those resources might be and how teachers can use them to improve student learning, many contextual factors remain to be examined. What is at issue here is the interaction of teacher and context that supports teachers' capacities for learning what it takes to do their work.

Focus on Teaching as a Professional Practice

Teaching is a system of activities, performed by people with knowledge, skills and beliefs in contexts. What teachers do requires figuring out how to use what they bring to the classroom, what their students bring, and the resources available. What we don't know from research on context is how changing the circumstances of teaching would affect what teachers actually do under their new circumstances to have a differential impact on learning. In order to relate changes in teaching to professional development and the improvement of student learning, we argue that teaching should be represented as a dynamic, interactive, and context-related practice.

Characteristics of Competent Performance. Many research findings emphasize that successful work in practices like teaching involves flexible, intelligent improvisation, especially in the construction and maintenance of the social interactions that are crucial in work activities. Social psychologists have shown that the "task demands" of improvisational work entail *systems* of skills and knowledge to be integrated in action rather than decomposable subsystems that can be mastered one at a time and then used independently in practice.[90] In solving complex problems, it is mastering the *relations* among subsystems, including action scenarios as well as culture, identity, norms, and the like, that constitutes competent performance.[91] Some have argued that the proper unit of analysis when we are looking at the relationship between knowledge and action should be joint socially mediated activity in a cultural context.[92] We are attracted to this formulation of the relationship between knowledge and action because it helps in explaining how teachers' will to have all students succeed is shaped by the norms of his or her professional community and can be related to effective action in teaching all students.

The fundamental characteristic of action and thought in complex practices is that they are not isolated from one another. Knowledge builds on whatever the practitioner brings into the work. Even when work is routine, merely a matter of carrying out a set of procedures and rules, engaged participation is a continual process of reflective inquiry. Practice involves knowledge in action that responds to interactions across problem domains. The demands of context cannot always be predicted in advance. Successful work integrates both planning for learning and negotiating learning in the performance of the work.

Implications for Knowing and Doing the Practice of Teaching. Similar arguments about what knowledge is for the practice of teaching in particular echo through a large body of work on teacher cognition.[93] Commonly "improvisation" is used as a metaphor for the work of teaching, especially teaching that aims to engage students in sophisticated problem-focused work.[94]

Teaching, especially teaching that responds to differences in student characteristics, requires constant on-the-spot analysis and learning in context. Highly scripted instructional planning and execution are associated with more rigid patterns of student behavior in class.

This kind of knowing-in-action has been called "strategic knowledge," and it is distinguished from propositional knowledge and case knowledge by needing to be created in the particular circumstances of practice. It obviously cannot be created outside and carried into the context—it must be grounded in the practice of teaching.

We know little about either how teachers come to be ***able to use*** such strategic knowledge or about how they might ***learn to use*** it. These are essential areas for research. We do know, from analyses of knowledge use in other professions, that it is not productive to treat strategic knowledge for teaching as a collection of discrete knowledges and skills applied todiscrete tasks.[95] Accomplished professional practice is more usefully considered to be a ***system of actions*** that must be performed intentionally and coherently.

Even if we had a rich understanding of the task demands of teaching complex academic practices to diverse populations, we would still be only part way toward ensuring that teachers know how to do these tasks systematically and coherently. Elements of the system we need to understand include:

Figuring out what students know
Planning and rehearsing for and reflecting on teaching
Selecting and using materials/tasks
Arranging the physical environment
Constructing relations with and among students
Establishing and maintaining a social learning environment
Working and communicating with other adults (parents, colleagues, administrators)
Managing the teacher's time, organization, record keeping, communication
Managing classroom routines and time

Doing successful teaching involves the ability to use knowledge and skill to perform and integrate these elements of practice—not only knowing when to use them but knowing how and intending to make the effort. Research on teacher development needs to investigate both how these systems of action function in teaching to promote student learning, and how they are acquired by professionals.

The Role of Professional Learning in Teaching. Changes in teaching practice will not happen unless teachers have opportunities to learn to practice their profession responsibly. This means that research needs to examine not only how teachers can learn to improve learning for all students, but how teaching can be organized to make professional learning an integral part of its fabric.

Policy, curriculum, improved subject matter knowledge, additional resources, and salary incentives have all been known to "change teaching," but we have little understanding of the mechanisms by which these interventions bring about improvement in teachers' strategic knowledge. As catalysts for change, these interventions are always filtered through teachers, individually and as a profession.

We do understand that the norms of communities of professional practice can stymie efforts to educate teachers to teach differently. The assumption that professionals get trained for their work before they start, and then just do what they have been trained to do, is false. People always learn in their activity, however it is arranged. But their learning does not necessarily develop the complex abilities needed for effective practice. Instead, people can develop strategies of coping superficially with the requirements of work without personal engagement in the activity. For example, teachers can learn in practice ***not*** to expect all students to achieve to high standards. We must figure out how to organize practice to produce the more desirable outcome of high expectations for all and the sense of efficacy that accompanies it.

As we argued above, teaching entails complex problem solving in particular contexts. Teachers do not form their expectations of students in isolation, and thus they do not "learn" to teach students from racial, ethnic, and linguistic minorities in isolation. The research on the characteristics of effective schools cited above suggests that the will to succeed with all students is strongly influenced by the kinds of interactions teachers have with their students and their professional peers. Research focused on teaching as a profession would thus recognize the importance of teachers' participation in professional communities and provide better understanding of the ways in which collegial interactions support the continued learning needed to strengthen teaching practice.[96] These communities are, for better or worse, powerful settings for professional development and for teacher education, even at the preservice and induction levels. Participation in a successful community of practice provides career trajectories in which individuals build professional identities.

The Effect of Teachers' Professional Development on Teaching

A broad look at what is known about teaching and how it affects students learning led us to focus on teaching as professional practice. If we regard teaching as professional practice, how can teacher development affect what teachers do and thereby improve what students can learn? We focus more pointedly here on what is known (or not known) about a set of related questions:

- Under what conditions can the teaching profession support the kind of learning that would enable changes in practice toward achieving the student learning goals we have identified?
- What is entailed in learning how to teach, given that teaching involves not only skill and knowledge but the will to succeed with all students and the ability to construct actions in response to the context?
- What do we know about contexts and pedagogies of teachers' professional development as it relates to learning the work of teaching—that is, what is entailed in teaching how to teach?
- Where does our knowledge in each of these areas break down in decoupling school success from race, ethnicity, gender, and social class?

Lack of Opportunities to Learn In and From Practice. One crucial factor in the failure of reform has been a repeated lack of opportunity for teacher learning. In the curriculum reforms of the 1950s and 1960s, the kinds of "training" offered to teachers afforded few opportunities to learn to use the new materials. The same appears to have been true with the many new curricula that NSF and other agencies have sponsored since that time, and with recent efforts at standards-based reform. Whether efforts to improve schools have succeeded or failed, they rarely include attention to the demands they place on teachers or to what happens in the daily work of teaching to contribute to their success or failure. But when teachers have had opportunities to learn what the reforms require, we observe that they have responded much more constructively. Almost no research exists that can give us insight into what and how teachers learn from practice or how practice could be organized to provide greater opportunities for teacher learning.

Most professional education is disjoint from professional practice in public education. A persistent problem of teacher education and professional development is that teachers often cannot use the ideas they learn, or that they find the subject matter irrelevant. No matter what gets emphasized in teacher education or what kind of institutional structure exists for professional development, skills, knowledge, and dispositions are taught in isolation from the settings in which they must be used, thereby setting up the problem of "transfer." Sometimes a lack of support is blamed for the lack of transfer of what teachers learn.

Although both relevance and support may be crucial to overcoming the disjunctures between professional education and teaching practice, there is also growing evidence that these gaps arise as a consequence of the complexity of using knowledge in teaching.[97] Learning more about discrete mathematics, for example, does not necessarily enable teachers to notice, interpret, or use children's ideas about counting; learning more about the role of interpretation in understanding literature does not necessarily result in teachers designing lessons that engage students in interpretive activities; learning about the characteristics of different ethnic and racial groups does not change the way teachers teach students from those groups.

Four categories of professional interaction appear to support learning in practice.[98] First, teachers and administrators in successful schools are more likely to talk about teaching practice. Talking about teaching practice is distinct from talking about teacher characteristics and failings, problems with students and their families, and the demands of society on schools. Rather, it is concrete and focused. Second, teachers in successful schools observe colleagues teaching and provide feedback and critique. Third, these teachers plan and design curriculum and lessons together. Fourth, these teachers actively teach each other how to teach, taking on leadership roles during in-services. Teachers need time for guided cycles of collaborative consideration, communication, reflection, and action. Peer coaching has proven successful, but it must center on curriculum and instruction, and the specific focus of the coaching sessions must emerge from the teachers' own contexts.[99]

Limited Appreciation of Changing One's Practice On the Individual Level. The simple model of learning to teach that has dominated both the design of teacher education and the conduct of research on teacher change is that knowledge goes in during teacher education and professional development and then comes out to be used in classrooms.[100] Conventional schooling, from kindergarten through college, teaches us that knowledge is lodged in textbooks, experts, and people with more experience. It comes in the form of rules, definitions, and facts that are to be remembered, practiced, and applied. Being a good learner means learning the rules well and applying them appropriately.

Such assumptions about learning are at odds with what we know about the role of knowledge in the activities of teaching.[101] We reject the notion that being able to teach competently transfers easily from one context to another. If teaching is complex in the ways described above, we cannot just do research on the activities of successful teaching of "high literacy" to diverse student populations and then deliver what we learn in the form of courses or workshops. Constructing action in the context in which knowledge needs to be used is an essential aspect of teaching,[102] and one must be attentive to the consequences of action and prepared to make speedy shifts of direction. When an appreciation for this kind of deliberate action is absent, the connection between knowing and doing is truncated to the "application of theory to practice" or the enactment of learned technical skills.[103] It is not professional development.

We need to know more about conventional expectations so teachers can learn to share the responsibility for solving the problems of practice. We have learned from research in other nations that this view of learning to teach is not internationally consistent. Recent research in and from other countries suggests that teachers' work and their professional cultures can support learning in professional practices.[104]

The TIMSS case studies make the connections among school cultures, professional development, and teacher enhancement very clear, for there appear to be important differences in school culture, particularly around the ways in which teachers come together and the degree to which this collaboration supports teachers learning in and through practice.[105] [106] [107].Further research can elaborate on these ideas.

Limited Appreciation of Changing Teaching Practice On the Institutional Level. In all, almost 1300 public and private institutions prepare teachers. Although about a third of them—mostly large public universities—prepare three-fourths of the teachers, the structure of teacher education programs varies widely. The variation is multiplied when one looks at program structure. Some teacher preparation occurs at the undergraduate level as part of either a four-year bachelor's degree program or a five-year program; some teacher preparation occurs at the post-B.A. level, as a fifth-year program. Some programs comprise alternate routes to certification. Most of these aim to recruit non-traditional students with degrees in other fields.

Professional development for practicing teachers is yet more diffuse. Teachers enroll in master's degree programs, earn continuing education credits, and take or are "delivered" a noncoherent "program" of study ("program" is a misnomer in this case). The "staff development industry" is a vast enterprise, with many different kinds of organizations, institutions, groups, and individuals sponsoring opportunities for teachers. These offerings are not coordinated in any way, and teachers' histories comprise experience with a wide assortment of disparate activities. Teachers' opportunities to learn are fragmented and superficial, and they often have little effect on practice.

Instructors and teacher developers, too, compose no homogeneous group. Although we tend to think of faculty in schools of education when we speak of "teacher educators," prospective teachers in fact spend more time in classes taught by faculty in the arts and sciences than by faculty in education departments. This is no small influence on prospective teachers' development.

Although multiple systems exist for licensing or certifying classroom teachers, with more or less attention given to teachers' ability to teach effectively, there are no such requirements for becoming a teacher educator. The most common route to this career in higher education is a Ph.D. or Ed.D. in "Curriculum and Instruction" or one of the foundational disciplines, and the degree programs rarely include experience in classroom teaching. Providers of professional development are even more varied than preservice teacher educators. Certainly, one form of teacher development is still taking courses at colleges and universities, but there are also a myriad of "workshops" of shorter and longer durations, in and out of the school system. Although no one knows whether teachers of teachers are prepared to support teachers learning in practice as we have described it here, the evidence suggests there is a serious deficit in this area. We know little about what successful supporters of teachers do, and we know even less about how they learn to do it.

Learning in Communities of Practice. As we noted above, research has identified some school settings where teachers can take professional responsibility for improving their practice with all students and make a particular commitment to students from traditionally underserved populations.[108] This research has done far more to illuminate the school as a professional community than to show precisely how schools actually achieve differential effects on students. General staff cooperation and morale have a weak relationship to student experience and achievement, and strong professional communities can constrain teacher learning and success with all students as well as promote it.[109] What makes the difference is whether the culture of practice—beliefs, norms, and organizational policies—engenders high or low expectations for the success of all students and encourages or discourages teacher learning and collective responsibility.[110] Collaboration around the tasks of teaching also seems to improve student learning.

Research has steadily converged on the importance of teacher learning communities and, at the same time, on the relative difficulty of creating and sustaining those communities that are successful in enhancing the impact of teaching on student learning.[111] A "teacher learning community is not simply the collection of good and committed teachers," but a group that develops collective expertise by employing problem-solving, critique, reflection, and debate.[112] As the prior studies would lead us to anticipate, however, such practices fly in the face of traditional norms of professional practice. Typically, frustrated teachers must work in professional environments with powerful norms of privacy. They are less likely to be challenged about outdated assumptions about practice or students and also are less likely to receive support for trying something different. As a "target population" they present special challenges for those who would seek to educate them and for scholars who seek to understand how teacher development can improve school achievement for all students.

IV.3. Proposed Research Priorities

The research program we recommend is designed to inform our thinking about this set of assertions by investigating:

- Particular kinds of teaching practice, namely how teachers might teach poor and racially and ethnically diverse students in K-12 schools so that they achieve high academic standards
- How those practices can be learned
- How schools can simultaneously support learning by all teachers and by all students.

If teachers' professional development and improving student learning in currently unsuccessful schools are to be connected, learning to teach within the context of professional development would:

- Be situated in the activity domains of teaching, i.e., in how teachers do their work
- Be heavily influenced by the kinds of teaching that teachers are learning and the kinds of students they are teaching.
- Be attentive to differences among school subjects as well as within subjects in terms of the level of learning expected.

Research could support professional development by:

- Identifying the types of activity involved in teaching K-12 students in particular classroom settings
- Investigating what it takes to teach effectively with activities of each of these types when the students live in poverty or are from ethnic, racial, and linguistically diverse communities
- Investigating how teachers learn to teach well with these types of activity—i.e., how teachers throughout their careers develop the abilities to do this work
- Investigating what it takes to teach professionals in the various institutional organizations in which professional development occurs—i.e., identifying the activities that teach teachers to be masters of their practice when their students live in poverty or are from ethnic, racial, and linguistically diverse communities
- And finally, examining how those who support the professional development of teachers might learn their practice.

We propose research that takes account of what we know about the relationship between research and practice and takes advantage of current reform efforts. We emphasize an approach to research that is sensitive to teaching and learning at three levels: K-12 classrooms, teacher development, and training of teacher educators.

Use Existing Reform Efforts for Research on Teachers' Professional Development

Though the approach to research we have outlined -- beginning with identifying effective teaching activities and moving to how teachers learn those activities and then to how teacher developers might support that teacher learning -- has a neat linear logic, we do not think that research has the leisure to proceed one step at a time. Time is short for many American children. And America is populated with an extraordinary variety of efforts—large and small—to improve teaching and learning. Some of these efforts are "ordinary" in the sense that they are part of the continuous stream of new ideas that enter schools regularly. Others are extraordinary, in that they represent large-scale efforts to change how instruction is delivered. Both types of reform offer unparalleled opportunities to learn about teaching and professional education by capitalizing on contemporary efforts to improve them. One keystone of the approach to research that we propose is to use existing efforts to reform/improve teaching and learning to learn more about the issues above. These efforts can be treated as hypotheses about what will work, what will make a difference.

Each of these kinds of reform is an opportunity to create a learning context for teachers, that is, a context for learning practice situated in practice itself. We suggest focusing on what can be learned in each setting about ways in which teachers are or are not able to use those contexts to learn to succeed in teaching all children. In both "ordinary" settings and settings where substantial reform efforts are under way, research is needed to investigate:

- what place learning a particular kind of teaching practice—namely, what it takes to teach all students to achieve academic success in K-12 schools—has in the conception of reform
- whether practitioners are supported in reconfiguring what their practice is about
- what motivation/incentives for change exist in the teaching practices that are being learned
- where teacher learning takes place (in the classroom and not) and what pedagogies support teacher learning
- what is effective across a teacher's career.

In order to investigate these questions, researchers would need to:

- identify practices that aim to teach children and adolescents living in poverty and from ethnic, racial, and linguistically diverse communities to learn powerful and usable academic skills, knowledge, and dispositions
- develop systematic methods for investigating teaching practice and teacher development in reform sites
- develop ways to represent teaching practices and useful concepts, frameworks, and language that link teacher development, what teachers do, and what students learn in particular contexts
- create/design (experimental) sites where teaching and teacher development can be undertaken and investigated in systematic ways that link teacher learning with student learning but that are not possible to investigate in existing sites.

Existing sites for research could include:

1. Reform programs aimed at structural and cultural change in schools and systems. These improvement efforts focus on various elements of the large structure or overarching culture of schools and systems, on the assumption that changing global features of schools and systems will create change in teaching and learning. They include changes in standards and incentives; changes in schools' curriculum, culture, and instruction; resource changes like class size

reductions, fiscal supplements for high poverty schools; and reforms in the professional culture and organization of districts.

2. Changes in the content and media of K-12 instruction that are intended to change student learning. This set of improvement efforts focus on various elements of the instructional infrastructure of schools or systems. The assumption seems to be that changing that infrastructure will create new opportunities for teachers to instruct or/and for students to learn. Examples include new curricula, new classroom participation structures, and new educational technologies.
3. Reform programs aimed toward changes in professional education across teachers' careers. Reforms intended to change teachers' education and learning may or may not change teaching and learning in schools. Examples include courses using multimedia materials and written cases to situate professional learning in practice, professional development schools, and other school-based teacher development programs.
4. Reform programs aimed toward changes in professional roles, responsibilities, and organization. These may be intended to change influence, incentives, or professional culture and thereby to improve teachers' knowledge and effectiveness. Programs include local school restructuring; creation of mentor roles; internal role differentiation (teachers who become part-time professional educators) in both professional development schools and teacher research collaboratives.

Because few reforms are designed to link teacher development, teaching, and student learning, researchers may also need to design experiments to test new hypotheses about how these practices may be linked.

Take Account of What We Know About the Complex Relationships Between Research and Practice

In the conventional model for relating research to practice in education, researchers produce "knowledge" about learning and teaching (AKA "the knowledge base"), and teaching changes as teachers put "it" into practice after they are taught "it" by teacher educators across the span of their careers, from preservice to retirement. Given what has been learned in research about the nature of complex practices and about the nature of learning, we reject these conventional notions about the relationship of research both to K-12 practice and to teachers' professional development.

Drawing on the analysis of how work proceeds in the natural sciences discussed in section II above,[113] we suggest that the possible relationships between the production of scholarly understanding and changes in teaching and teachers' professional development can fall into three categories:

1. scholarly inquiry that investigates phenomena for the purpose of producing explanatory understanding (e.g., Bohr in science, educational researchers who observe and compare what happens when new standards are introduced in different districts and create explanations of the variation related to availability of resources)
2. practical inquiry that produces solutions to immediate problems (e.g., Edison in science; staff developers who figure out how to use newly available classroom videos in teacher development)
3. scholarly inquiry that investigates phenomena to produce solutions to immediate problems, thereby also producing an understanding of those problems and how they are solved (e.g., Pasteur in science; researchers and teachers who work collaboratively to create a new cross-age organization for instruction and investigate what happens when it is implemented).

As is discussed in Section II on Strengthening Research Capacity For Improving Education, the relationship between research and practice needs to be restructured, this restructuring is particularly relevant to the notion of strengthening professional communities of practice in teaching. Important research on teacher development can be done at the level of building scientific theory, at the level of practical inquiry, *and* in "Problem-Solving Research and Development Federations."

Attend to Teaching and Learning at Various Levels

Investigating the causal connections from teacher professional development to teacher learning to teaching practice to student learning implies that we must pay attention, in all of these settings, to three different levels at which teaching and learning occur:

- K-12 classrooms where students learn to do academic activities competently
- settings where teachers learn to do teaching activities competently
- settings where people who support the professional learning of teachers learn to do the activities involved in teacher development competently.

Often we think of the problems of teaching and learning as situated solely in K-12 classrooms. But our focus on teacher development requires us to pay attention to problems of teaching and learning at these other levels as well. Because teaching and learning at the level of professional development have K-12 teaching and learning as their focus, we must attend to them simultaneously. We are thus concerned with three different *learner* populations and three different *teacher* populations.

- We must pay attention to a particular population of learners in K-12 schools (their characteristics are given by our charge).
- We must also pay attention to the particular population of teachers who teach these students, in their role as learners of teaching.
- We cannot ignore the people from whom these teachers can learn or those who will support them in learning how to provide teacher development.

We are also concerned with three different "contents" to be taught and learned. (N.B. Context and pedagogy matter within each kind; we do not mean to suggest that these contents can be generically identified and delivered by teachers to learners. See section on context below.)

- In the K-12 classroom, the content to be taught and learned involves high achievement in reading, writing, speaking, mathematics, the social and natural sciences, and the arts that are taught in school
- In the places where teachers learn their practice (i.e., professional development settings), the content to be taught and learned is the activities involved in teaching the academic practices to K-12 learners (including the ability to perform those academic practices)
- In the setting in which teacher educators learn, the content is the activities involved in teaching teaching practice to teachers (including the ability to perform those teaching practices)

And, finally, we are concerned with three different levels of *organizational/ social/ institutional context* in which teaching and learning take place. How teaching and learning happen differs depending on what is to be taught and learned.

- K-12 schools and classrooms where teachers and students negotiate what is to be taught and learned and how it is done
- classrooms, schools, and school districts in which teaching, learning, and what is to be taught and learned are negotiated by *teachers and those from whom they can learn their practice* (including teachers learning by themselves, as well as learning from other teachers and resource partners)
- places in which teaching, learning, and what is taught and learned are negotiated by *those who teach teachers and those from whom these "teachers of teachers" can learn*

The elements worthy of our attention at each of these levels are summarized in figure 4. By portraying the "contents" of K-12 teaching and learning, teachers' teaching and learning, and professional developers' teaching and learning as nested in this way, we must observe two cautions: (1) The content that must be learned is not a static, generic package that can be delivered to each

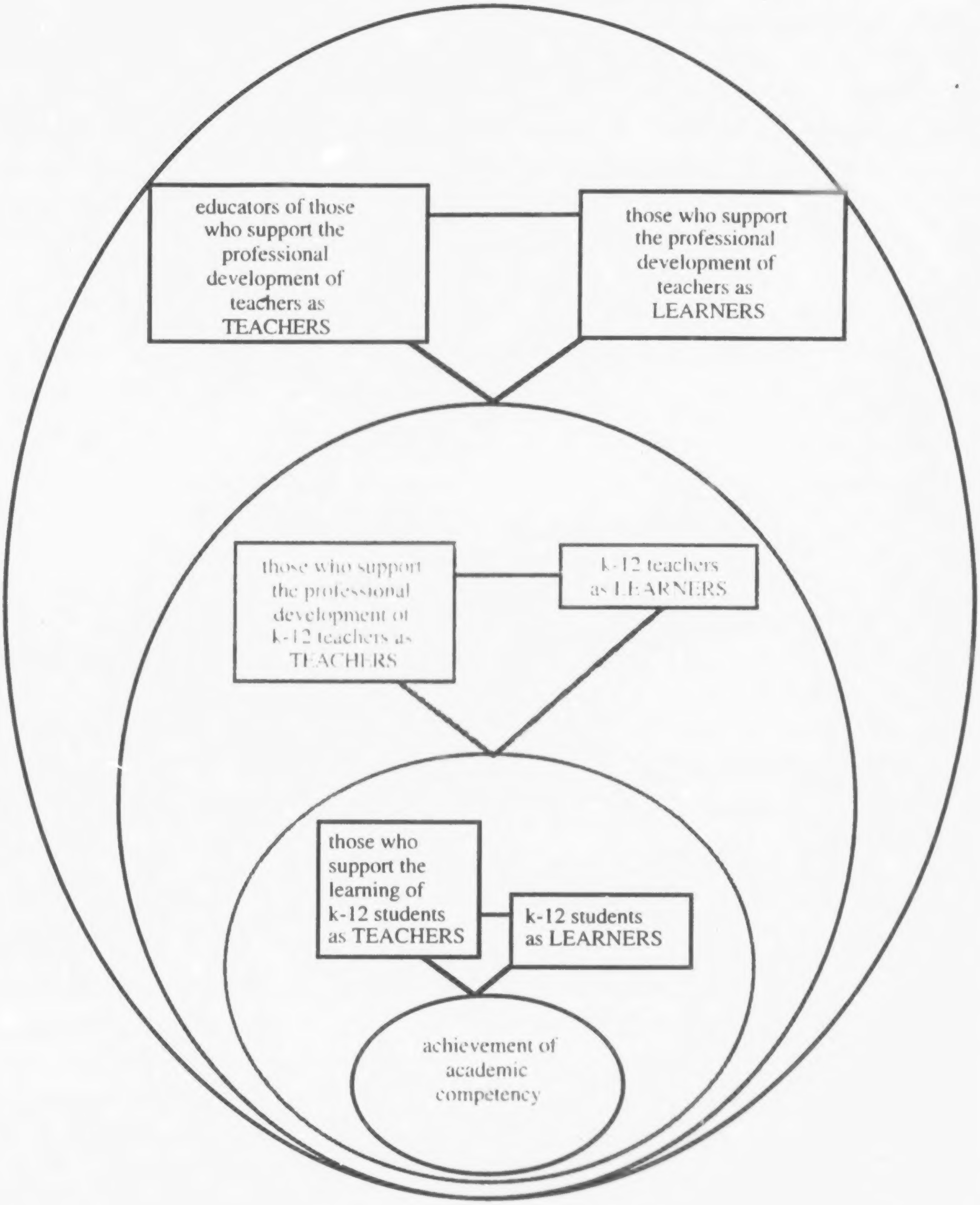
educators of those who support the professional development of teachers as TEACHERS
those who support the professional development of teachers as LEARNERS
those who support the professional development of k-12 teachers as TEACHERS
k-12 teachers as LEARNERS
those who support the learning of k-12 students as TEACHERS
k-12 students as LEARNERS
achievement of academic competency

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figure 2

setting and used there. At all levels, contexts and resources matter to teaching and learning. And (2) The roles and people who enact them are disjoint. Teachers can be teacher educators or researchers, researchers can be teachers or teacher educators, teacher educators can be teachers or researchers—the focus here is on the different practices at each level and the contents of these practices, not on people and their formal titles or roles.

Because we regard what students do in K-12 classrooms as complex academic practices and we regard teaching as a complex practice, we must recognize that both school learners and their teachers engage in some form of inquiry as they do their work. In practice, learning is active engagement with problems, not passive reception of knowledge skills and dispositions. In the figure, who the learners are and who the teachers are gets muddier as we move out from the center. K-12 teachers engage simultaneously in teaching children and adolescents and in learning, and as learners, they engage in inquiry—or research on teaching—as well.

IV.4. Conclusion

In this section, we have attempted to create a different vision of what teaching can be. It entails taking responsibility for one's own and the profession's learning. We argue that educational research can support this vision by:

1. Focusing on studying the practices of learning to teach and the practices of teaching, given what we have said about what needs to be taught and learned.
2. Looking specifically at practices of learning and teaching this kind of teaching where the student population is particularly underserved and where the learning goal is high achievement in reading, writing, speaking, mathematics, the natural and social sciences, and the arts that are taught in school.
3. Formulating and examining hypotheses about how to make the learning aspect as it occurs in teaching progressively productive -- how to arrange the activities of the practice in a way that either impedes or supports continuous professional learning.
4. Investigating how there can be learning that improves practice in situations other than those in which the practice occurs.
5. Clarifying what could be meant by teaching in and from practice in different types of activity that are involved in the practice.
6. Investigating characteristics of teachers' learning throughout their careers.

If we take seriously the notion that teaching is the kind of practice that requires systemic rather than segmented knowledge for its improvement, and that acquiring that knowledge is the responsibility of both the profession and those who inhabit it, we cannot limit ourselves to research on the effects of improving teachers' knowledge and skill on student learning outcomes.

Notes

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[1] D. E. Stokes, *Pasteur's Quadrant: Basic Science and Technological Innovation.* Washington DC: Brookings Institution Press, 1997.

[2] Stokes, *op. cit.*, p. 88

[3] S.P. Robinson & the National Educational Research Policy and Priorities Board, *Building Knowledge for a Nation of Learners: A Framework for Educational Research.* Washington DC: US Department of Education, 1997.

[4] D. C. Berliner & B. J. Biddle, *The Manufactured Crisis.* Reading, MA: Addison-Wesley, 1995. G. W. Bracey, *The Truth About America's Schools: The Bracey Reports, 1991-97.* Phi Delta Kappa Educational Foundation, 1997.

[5] J.G. Greeno (Chair), P.D. Pearson, & A.H. Schoenfeld (Co-chairs). "Research Relevant to the National Assessment of Educational Practice." In R. Glaser & R. Linn (Chairs) & G. Bohrnstedt (Project Director), *Assessment in Transition: Monitoring the Nation's Educational Progress, Background Studies* (pp. 151-215). Stanford, CA: National Academy of Education, 1977.

[6] J.P. Heubert & R.M. Hauser, *High Stakes: Testing for Tracking, Promotion, and Graduation.* Washington, DC: National Academy Press, 1999.

[7] A.L. Brown, "Design Experiments: Theoretical and Methodological Challenges in Creating Complex Interventions in Classroom Settings," *Journal of the Learning Sciences,* 1992, *2,* pp. 141-178. A. Collins, "Toward a Design Science of Education." In E. Scanlon & T. O'Shea, *New Directions in Educational Technology,* pp. 15-22. Berlin: Springer, 1992.

[8] D.E. Shaw (Chair). *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States.* Washington, DC: President's Committee of Advisors on Science and Technology, 1997.

[9] R.C. Atkinson & G.B. Jackson (Eds.). *Research and Education Reform: Roles for the Office of Educational Research and Improvement.* Washington, D.C.: National Academy Press, 1992. M.M. Kennedy. "The Connection Between Research and Practice." *Educational Researcher,* 1997, *26*(7), pp. 4-12. K.S. Louis, R.A. Dentler, & D.G. Kell. *Putting Knowledge to Work: Issues in Educational*

Dissemination. Boston, MA: Abt Associates, Inc., and the Center for Survey Research, University of Massachusetts, 1984.

[10] L.B. Resnick & M.W. Hall. "Learning Organizations for Sustainable Education Reform." *Daedalus,* 1998, *127*(4), pp. 89-118.

[11] *Quality Counts.* An Education Week/Pew charitable Trusts report on education in the 50 states. Washington, DC: Editorial Projects in Education, Inc., 1999.

[12] P.D. Forgione. *Achievement in the United States: Progress Since* A Nation at Risk*?* Washington, D.C.: National Center for Education Statistics, April 3, 1998.

[13]B.R. Foorman, J.M. Fletcher, D.J. Francis. "Preventing Reading Failure by Ensuring Effective Reading Instruction." In S. Patton & M. Holmes (Eds.) *The Keys to Literacy* (pp. 29-39). Washington DC: Council for Basic Education, 1998.

[14] J. Kozol. *Savage Inequalities: Children in America's Schools.* New York: Crown Publishers, 1991.

[15] L. Darling-Hammond. "Restructuring Schools for High Performance." In S.H. Fuhrman & J.A. O'Day (Eds.), *Rewards and Reform: Creating Educational Incentives That Work.* San Francisco: Jossey-Bass, 1996.

[16] R.F. Elmore. "Getting to Scale with Good Educational Practice." *Harvard Educational Review,* 1996, *66*(1), pp. 1-26.

[17] L. Cuban. *Teachers and Machines: The Classroom Use of Technology Since 1920.* New York: Teachers college Press, 1986. B. Means. (Ed.). *Technology and Education Reform: The Reality Behind the Promise.* San Francisco: Jossey-Bass, 1994.

[18]A.L. Brown, 1992. *op.cit.*.

[19] C.F. Kaestle. "The Awful Reputation of Educational Research." *Educational Researcher,* 1993, *22*(1), pp. 23-31. M.M. Kennedy. "The Connection Between Research and Practice." *Educational Researcher,* 1997, *26*(7), pp. 4-12.

[20] R. Havelock. *Planning for Innovation Through Dissemination and Utilization of Knowledge.* Ann Arbor, MI; Institute for Social Research, 1969.

[21]D. E. Stokes, 1997, *op. cit.*

---

[22] D. E.. Stokes, 1997, *op. cit.*, p. 73

[23] A. S. Bryk, S. G. Rollow, & G. S. Pinnell. "Urban School Development: Literacy as a Lever for Change." *Educational Policy.* 1996, *10*(2), pp. 172-201.

[24] L. B. Resnick, A. J. Alvarado, & R. F. Elmore,. *Developing and Implementing High-Performance Learning Communities.* Proposal submitted to Office of Educational Research and Improvement, 1996.

[25] Reading Recovery. See M. M. Clay. "Implementing Educational Reading Recovery: systematic adaptations to an educational innovation." *New Zealand Journal of Educational Studies,* 1987, *22*, pp. 351-358.

[26] E.A. Silver & M.K. Stein. "The QUASAR Project: The 'Revolution of the Possible' in mathematics instructional reform in urban middle schools." *Urban Education,* 1996, *30*(4), pp. 476-521.

[27] The Co-Vis Project. See R.D. Pea, L.M. Gomez, D.C. Edelson, B.J. Fishman, D.N. Gordin, & D.K. O'Neill. "Science Education as Driver of Cyberspace Technology Development." In K. C. Cohen (Ed.), *Internet Links for Science Education,* (pp. 189-220). New York: Plenum Press, 1997.

[28] R.E. Slavin. *Every Child, Every School: Success for All.* Thousand Oaks CA: Corwin Press, 1996.

[29] Cognition and Technology Group at Vanderbilt. "The Jasper Series as an Example of Anchored Instruction: Theory, Program Description and Assessment Data." *Educational Psychologist,* 1992, *27*(3), pp. 291-315.

[30] A.S. Bryk & P.B. Sebring. *Informing Chicago School Reform: The Work of the Consortium on Chicago School Research.* Paper prepared for NAE Panel on Strengthening the Capacity of Research to Contribute to Practice, October, 20, 1998. L. B. Resnick et al., 1996, *op. cit.*

[31] J.G. Greeno, R. McDermott, K. Cole, R.A. Engle, S. Goldman, J. Knudsen, B. Lauman, & C. Linde. *Research, Reform, and Aims in Education: Models of Action in Search of Each Other.* Institute for Research on Learning and Stanford University, 1998.

[32] R. D. Pea, *et al.*, 1997, *op. cit.*

[33] E.A. Silver & M.K. Stein, 1996. *op. cit.*

---

[34] R. G. Tharp & R. Gallimore. *Rousing Minds to Life: Teaching, Learning, and Schooling in Social Context.* Cambridge, MA: Cambridge University Press.

[35] The Fostering Communities of Learners Project. A.L. Brown & J.C. Campione. “Communities of Learning and Thinking, or a Context by Any Other Name.” *Human Development,* 1990, *21,* pp. 108-125.

[36] M.K. Stein, M.S. Smith, M. Henningsen, & E.A. Silver. *Mathematical Instructional Tasks: A Casebook.* New York: Teachers College Press, in press.

[37] J. Hutchinson & M. Huberman. *Knowledge Dissemination and Use in Science and Mathematics Education: A Literature Review.* Report prepared for the Directorate of Education and Human Resources, Division of Research, Evaluation and Dissemination, National Science Foundation by The Network, 1993.

[38] D.K. Cohen & D.L. Ball. “Relations Between Policy and Practice: A Commentary. “*Educational Evaluation and Policy Analysis,* 1990, *12*(3), pp. 249-256.

[39] M. Cole. “The Zone of Proximal Development: Where Culture and Cognition Create Each Other.” In J.V. Wertsch (Ed.), *Culture, communication, and cognition: Vygotskian perspectives* (pp. 146-161). Cambridge, England: Cambridge University Press, 1985.

[40] L.B. Resnick, R. Saljo, C. Pontecorvo, & B. Burge. *Discourse, Tools, and Reasoning: Essays on Situated Cognition.* Heidelberg, Germany: Springer-Verlag, 1997.

[41] *Institute for Learning Two-Year Report* (1995-97). Pittsburgh, PA: Learning Research and Development Center.

[42] R.F. Elmore & D. Burney. *Investing in Teacher Learning: Staff Development and Instructional Improvement in Community School District #2, New York City.* Paper prepared for the National Commission on Teaching and America’s Future and the Consortium for Policy Research in education, 1997. M.K. Stein & L. D’Amico. *Content-Driven Instructional Reform in Community School District #2.* Pittsburgh, PA: Learning Research and Development Center, 1998.

[43] R.F. Elmore, 1996, *op. cit.*

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[44] For example, CREDE (Center for Research on Educational Diversity and Excellence) consists of five sets of hub and spokes: Language Learning and Achievement; Professional Development: Family, Peers, and Community; Instruction in Context: and System-Wide Reform. CREDE "Central" is a hub of hubs, integrating at a higher level of principle and coherence for a comprehensive view of improving education for diverse at-risk students. Other examples of a hub-and-spokes arrangement are two OERI-funded centers: CRESPAR and the Mathematics and Science Center at the University of Wisconsin. Although all of the projects undertaken in the spokes of these enterprises may not be examples of problem-solving research and development, the organization and sets of social relationships are very similar to what we mean by hub-and-spokes research federations.

[45] United Nations, *Report of the Human Development Project.* New York: United Nations Printing Office, 1994.

[46] US Census Bureau, *Money Income in the United States.* <http://www.census.gov/hhes/www/income97.html>, 1997; Poverty in the United States, <http: www.census.gov/hhes/www/povty97.html>, 1997.

[47] K. Haycock,. *Education Watch.* Washington, DC: "The Education Trust", 1996. J. Oakes, *Keeping Track: How Schools Structure Inequality.* New Haven, CT: Yale University Press, 1985. J. Oakes, A. Gamoran, & R. N. Page, "Curriculum Differentiation: Opportunities, Outcomes and Meanings." In P. Jackson (Ed.), *Handbook of Research on Curriculum* (pp. 570--608). New York: Macmillan, 1993.

[48] J. Oakes, *et al.*, 1993, *op. cit.* A. V. Cicourel, & H. Mehan, "Universal Development, Stratifying Practices and Status Attainment." *Research in Social Stratification and Mobility,* 1983, *4*, pp. 3--27. J. Mercer, *Labeling the Mentally Retarded.* Berkeley: University of California Press, 1973. R. P. McDermott & H. Varenne, "Culture as Disability." *Anthropology and Education Quarterly,* 1995, *25*, pp. 324--348; H. Varenne & R. P. McDermott, *Successful Failure.* Boulder, CO: Westview Press, 1998.

[49] C. Snow, M. S. Burns, & P. Griffin (Eds.), *Preventing Reading Difficulties in Young Children.* Washington, DC: National Academy Press, 1998.

[50] D. August & K. Hakuta, *Improving Schooling for Language-Minority Children: A Research Agenda.* Washington, DC.: National Research Council, 1997.

---

[51] G. Vernez & R. Krop, *Projected Social Context for the Education of Children: 1990-2015.* Santa Monica, CA: RAND Report to the College Board's National Task Force on Minority High Achievement, 1998.

[52] National Council of Teachers of Mathematics, *Standards for Curriculum and Evaluation,* Reston, VA: NCTM, 1989. A revision of these standards, to be titled *Standards 2000,* is currently in preparation.

[53] Elementary school projects included: *Cooperative Mathematics Project: Number Power; TERC: Investigations in Number, Data, and Space; The TIMMS Project: Math Trailblazers; University of Chicago School Mathematics Project, Elementary: Everyday Mathematics.* Middle school projects included: *Connected Mathematics Project; Mathematics in Context; Middle-School Mathematics Through Applications Project; Seeing and Thinking Mathematically: MathScape; Six Through Eight Mathematics: Math Thematics.* High school projects included: *Applications/Reform in Secondary Education: Mathematics: Modeling Our World; Connected Geometry; Core-Plus Mathematics Project: Contemporary Mathematics in Context; Interactive Mathematics Program; MATH Connections: A Secondary Mathematics Core Curriculum; Systemic Initiative for Montana Mathematics and Science: Integrated Mathematics: A Modeling Approach Using Technology; University of Chicago School Mathematics Project—Secondary Component.*

[54] L. Delpit, *Other People's Children: Cultural Conflict in the Classroom.* New York: The New Press, 1995.

[55] E. A. Silver & M. K. Stein, 1996, *op. cit.*

[56] For example, in Moll's program called "Funds of Knowledge," students with different cultural and linguistic backgrounds contribute to each other's understanding as they discuss literary and historical issues from their differing perspectives and jointly write papers in their respective languages. L. C. Moll & K. F. Whitmore, "Vygotsky in Classroom Practice: Moving from Individual Transmission to Social Transaction." In E. A. Forman, N. Minick, & C. A. Stone (Eds.), *Contexts for Learning: Sociocultural Dynamics in Children's Development* (pp. 19-42). New York: Oxford University Press, 1993. In Brown and Campione's program called "Fostering Communities of Learners," students form research groups specializing in different topics within the general subject that the class is studying and prepare project reports that they then teach to students who have worked on different topics. A. L. Brown & J. C. Campione, 1990, *op. cit.* A program developed by Scardamalia and Bereiter, called "Computer Support for Intentional

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Learning," provides networked computers in classrooms in which students exchange information, questions, conjectures, examples, and arguments about the topics they are studying in science, social studies, history, or literature. M. Scardamalia & C. Bereiter, "Higher Levels of Agency for Children in Knowledge Building: A Challenge for the Design of New Knowledge Media." *Journal of the Learning Sciences,* 1991, *1,* pp. 37-68. In the "Middle-School Mathematics through Applications Project," developed by Goldman, Knudsen, Greeno, McDermott, and others, students learn mathematics by working on projects in design teams. J. G. Greeno & the Middle-School Mathematics Through Applications Project Group, "Theories and Practices of Thinking and Learning to Think." ***American Journal of Education,*** 1997, *106,* 85-126. Many mathematics teachers and curriculum developers have changed in the direction of having students discuss their ideas about conceptual issues in mathematics and focus on each other's mathematical thinking, e.g., D. Ball, "Unlearning to Teach Mathematics," ***For the Learning of Mathematics,*** 1988, *8,* pp. 40-48, P. Cobb, T. Wood, E. Yackel, J. Nicholls, B. Triganti, & M. Perlwitz, "Assessment of a Problem-Centered Second-Grade Mathematics Project." ***Journal for Research in Mathematics Education,*** 1991, *22,* pp. 3-29. M. Lampert, "When the Problem is Not the Question and the Solution is Not the Answer: Mathematical Knowing and Teaching." *American Educational Research Journal,* 1990, *17,* pp. 29-64.

[57] e.g., L. Delpit, 1995, *op. cit.*

[58] J. S. Chall, V. A. Jacobs, & L. E. Baldwin, *The Reading Crisis: Why Poor Children Fall Behind.* Cambridge, MA: Harvard University Press, 1990.

[59] A. Atwell, *In the Middle: New Understandings About Writing, Reading and Learning* (2nd Edition). Portsmouth, NH: Heinemann, 1998.

[60] A. H. Dyson, *Writing Superheroes: Contemporary Childhood,* Popular, 1997.

[61] M. Sperling, & S. W. Freedman, Research on Writing. In: V. Richardson (Ed.) *Handbook of Research on Teaching* (4th Edition). Washington DC: AERA, in press.

[62] e.g., K. Beach, (1995). "Activity as a Mediator of Sociocultural Change and Individual Development: The Case of School-Work Transition in Nepal." *Mind, Culture, and Activity,* 1995, *2,* pp. 285-302. G. Hull, M. Jury, O. Ziv, & K. Schultz, *Changing Work, Changing Literacy? A Study of Skill Requirements and Development in a Traditional and Restructured Workplace (Interim Report Two).* National Center for the Study of Writing and Literacy, University of California, Berkeley, 1994..J. Lave, *Cognition in Practice.* Cambridge, England: Cambridge University Press,

---

1998. T. Nunes, A. D. Schliemann, & D. W. Carraher, *Street Mathematics and School Mathematics.* Cambridge, England: Cambridge University Press, 1993. G. Saxe, *Culture and Cognitive Development.* Hillsdale, NJ: Lawrence Erlbaum Associates, 1990.

[63] A. Lesgold, M. J. Feuer, & A. Black (Eds.), *Transitions in Work and Learning.* Washington, DC: National Academy Press 1997. G. Hull (Ed.) 1997. *Changing Work, Changing Workers: Critical Perspectives on Language, Literacy, and Skills.* Albany, NY: SUNY Press, 1997.

[64] E. Tobach, R. J. Falmagne, M. B. Parlee, L. M. W. Martin, & A. S. Kapelman (Eds.), *Selected Writings of Sylvia Scribner.* Cambridge: Cambridge University Press, 1997. J. Lave, & E. Wenger, *Situated Learning: Legitimate Peripheral Participation.* New York: Cambridge University Press, 1991. A. Lesgold et al., 1997, *op. cit.* G. Hull, 1997, *op. cit.*

[65] S. B. Heath, S. B., & M. W. McLaughlin, (Eds.) *Identity and Inner-City Youth: Beyond Ethnicity and Gender.* New York: Teachers College Press.), 1993.

[66] M. Gibson, 1998. *Anthropology and Education Quarterly,* 1998. H. Mehan, I. Villaneuva, L. Hubbard, & A. Lintz, *Constructing School Success: The Consequences of Untracking Low Achieving Students.* Cambridge: Cambridge University Press, 1996.

[67] D. Entwisle, K. L. Alexander, & S. Olson, *Children, Schools, and Inequality.* Boulder, CO: Westview Press, 1997. B. Heyns, *Summer Learning and the Effects of Schooling.* New York: Academic Press, 1978.

[68] S. B. Heath & M. W. McLaughlin, *Meaningful Measures: Learning in Youth-Based Organizations in the Nonschool Hours.* Washington, DC: The Public Education Fund, forthcoming. F. Villarruel, & R. N. Lerner, R. N. (Eds.). "Promoting Community-Based Programs for Socialization and Learning." *New Directions for Child Development,* 1994, 63. S. B. Heath, *et al.*,. "Living the Arts Through Language-Learning: A Report on Community-Based Youth Organizations." *Americans for the Arts Monographs,* 1998, *2* (7) pp. 1-17.

[69] M. Cole, *Cultural Psychology: A Once and Future Discipline. Cambridge:* Harvard-Belkamp. 1998. O. Vasquez, *La Clase Magica.* in press

[70] J. G. Greeno, & S. V. Goldman, S..(Eds.) *Thinking Practices In Mathematics and Science Learning.* Mahwah, NJ: Lawrence Erlbaum, 1998. S. V. Goldman, J. Knudsen, & M. Latvala,

---

"Engaging Middle Schoolers in and through Real-World Mathematics." In: *Mathematics in the Middle School.* Washington, DC: NCTM, 1998.

[71] J. Oakes, et al., 1993. *op. cit.*

[72] E. G. Cohen, *Designing Groupwork: Strategies for the Heterogeneous Classroom.* New York: Teachers College Press, 1994. S. Kagan, "Cooperative Learning and Sociocultural Factors in Schooling." In *Beyond Language* (pp. 231–298). California State University Los Angeles: Evaluation, Dissemination, and Assessment Center, 1986. R. E. Slavin, "Achievement Effects of Ability Grouping in Secondary Schools: A Best Evidence Synthesis." *Review of Educational Research*, 1990, *60* (3) pp. 471–499.

[73] H. Mehan. et *al.*, 1996, *op. cit.* P. Gándara (Ed.) *Capturing Latino Students in the Academic Pipeline.* Berkeley, CA: Chicano Latino Policy Project Policy Report, 1998.

[74] H. Mehan, *et al.*, 1996, *op. cit.* S. Kagan, 1986, *op. cit.* R. E. Slavin, R. E. 1990, *op. cit.*. L. C. Moll, C. Amanti, D. Neff, & N. Gonzalez, "Funds of Knowledge: Using a Qualitative Approach to Connect Homes and Classrooms." *Theory into Practice,* 1992, *31* (2) pp. 132–141. C. Lee, . "A Culturally Based Cognitive Apprenticeship: Teaching African-American High School Students Skills in Literacy Interpretation". *Reading Research Quarterly* 1995, *30.* A. S. Roseberry, B. Warren, & F. R. Conant, "Appropriating Scientific Discourse: Findings from Language Minority Classrooms." *Journal of the Learning Sciences,* 1992, *2* (10). pp. 61-94. L. Delpit, . 1995, *op. cit.*

[75] J. Oakes, A. S. Wells, A. S., & Associates.. *Beyond the Technicalities of School Reform.* Los Angeles: UCLA Graduate School of Education and Information Studies, 1996.

[76] In this document, whenever we use the term "professional development" we mean the learning of teaching across the teachers' career, from preservice preparation through to the entire trajectory of learning that occurs simultaneously with being a teacher in K-12 schools.

[77] J. Brophy and T. L. Good. "Teacher Behavior and Student Achievement." In *1986 Handbook of Research on Teaching,* Third Ed. ed. M. C. Wittrock. (pp. 328-375). New York: Macmillian, 1986.

[78] J. Goodlad, *A Place Called School,* . New York: McGraw Hill., 1984

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[79] That point was first reported by W. W. Cooley, and G. Leinhardt, *The Instructional Dimensions Study: The Search for Effective Classroom Process* (Final Report). Washington, D. C.: National Institute of Education, 1978.

[80] For a review of these studies see L. Darling-Hammond, "Teaching and Knowledge: Policy Issues Posed by Alternative Certification of Teachers," *Peabody Journal of Education,* 67 (Spring 1992) pp. 123-154.

[81] G. Fenstermacher, "A Philosophical Consideration of Recent Research on Teacher Effectiveness," in L.S. Shulman (Ed.) *Review of Research in Education,* 1978, 6,. pp. 157-185.

[82] See Chapter 6 "Culturally Relevant Teaching" in G. Ladson-Billings, *The Dreamkeepers: Successful Teachers of African American Children* San Francisco: Jossey-Bass, 1994, pp. 102-126. See also, earlier work on effective teaching with non-white students by G. Mohatt and F. Erickson "Cultural Differences in Teaching Styles in an Odawa School: A Sociolinguistic Approach," In H. Trueba, G. Guthrie, and K. Au, (eds.), *Culture and the Bilingual Classroom: Studies in Classroom Ethnography* (pp. 105-119). Rowley, MA: Newbury House, 1981. K. Au & C. Jordan, "Teaching Reading to Hawaiian Children: Finding a Culturally Appropriate Solution." In H. Trueba, G. Guthrie, and K. Au, (eds.), *Culture and the Bilingual Classroom: Studies in Classroom Ethnography* (pp. 139-152). Rowley, MA: Newbury House, 1981.

[83] S. S. Stodolsky, *The Subject Matters: Classroom Activity in Math and Social Studies.* Chicago: University of Chicago Press, 1988. L. S. Shulman, "Knowledge and Teaching: Foundations of the New Reform," *Harvard Educational Review,* 1987, *57,* pp. 1-22. L. S. Shulman, "Those Who Understand: Knowledge Growth in Teaching." *Educational Researcher,* 1986, *15,* pp. 4-14. P. Grossman. *The Making of a Teacher: Teacher Knowledge and Teacher Education.* New York: Teachers College Press, 1990.

[84] Murnane and Levy, *Teaching the New Basic Skills: Principles for Educating Children to Thrive in a Changing Economy* NY: Martin Kessler Books, The Free Press, 1996.

[85] R. R. Edmonds, "School effects and teacher effects." *Social Policy 15* (Fall 1984) pp. 37-39. And, R. R. Edmonds, "Effective schools for the urban poor." *Educational Leadership 37,* 1997, pp. 15-27.

---

[86] M. Rutter, "School Effects on Pupil Progress: Research Findings and Policy Implications." In L. Shulman & G. Sykes (Eds.), *Handbook of Teaching and Policy* (pp. 3-41). New York: Longman, 1983. M. Rutter, B. Maughan, P. Mortimer, & J. Ouston, *Fifteen Thousand Hours: Secondary Schools and Their Effects on Children.* Cambridge: Harvard University Press, 1979. See also S. L. Lightfoot, *The Good High School: Portraits of Character and Culture.* New York: Basic Books, 1983.

[87] See A. Bryk, V. Lee, & P. Holland, *Catholic Schools and the Common Good.* Cambridge: Harvard: Harvard University Press, 1993.

[88] V. E. Lee, & J. B. Smith, "High School Size: Which Works Best and for Whom?" *Educational Evaluation and Policy Analysis,* 1997, *19*(3), pp. 205-227.

[89] F. Mosteller, "The Tennessee Study of Class Size in the Early School Grades." *Future of Children,* 1995, *5,* pp. 113-127,

[90] For example, Y. Engeström & D. Middleton,(Eds.), *Cognition and Communication at Work.* Cambridge, England: Cambridge University Press, 1996.

[91] J. G. Greeno, The Situativity of Knowing, Learning, and Research," *American Psychologist,* January, 1998, pp. 5-26 building on H.A. Simon, "The Structure of Ill-Structured Problems" *Artificial Intelligence,* 1973, *4* pp. 181-201.

[92] M. Cole and Y. Engeström "A Cultural-Historical Approach to Distributed Cognition" In G. Salomon (Ed.), *Distributed Cognitions* (pp. 1046), Cambridge University Press, 1993. Activity theory has also recently been used specifically to describe what teachers need to be able to do in relation to what they need to know, E. M. Guyton, "Teacher Cognition, Constructivist Teacher Education, and the Ethical and Social Implications of Schooling: Overview and Framework," in *Strategies for Career-Long Teacher Education* (pp. 1-10), Thousand Oaks, CA: Corwin Press, 1998. M. K. Stein, E. A. Silver, & M. Smith. "Mathematics Reform and Teacher Development: A Community of Practice Perspectisve," In J. G. Greeno & S. V. Goldman (Eds.), 1998; *op. cit.* R. Gallimore & C.N. Goldenberg, "Tracking the Developmental Path of Teachers and Learners: A Vygotskian Perspective," in F.K. Oser, A Dick, & J-L. Patry, (Eds.), *Effective and Responsible Teaching: The New Synthesis.* San Francisco: Jossey-Bass, 1992.

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[93] Reviewed in C. Clark. & R. J. Yinger, "Research on Teacher Thinking." *Curriculum Inquiry, 7* (4), 279-394; F. Elbaz, *Teacher Thinking: A Study of Practical Knowledge.* New York: Nichols Publishing Co. 1983, and C. Clark,. & P. L. Peterson, "Teacher's Thought Processes." In M. Wittrock, (Ed.) *Handbook of Research on Teaching* (3rd edition), New York: Macmillan: 1986.

[94] M. Huberman "The Model of the Independent Artisan in Teachers' Professional Relations, "in J.W. Little and M.W. McLaughlin. NY: Teachers College Press, 1993, pp. 11-50.

[95] E. Hutchins, *Cognition in the Wild* Cambridge, MA: MIT Press, 1995.

[96] Murnane and Levy, 1996, *op. cit.* make this argument based on studies of how employees learn in contemporary problem-solving-oriented workplaces.

[97] See M. Lampert and D. Ball, *Teaching, Multimedia, and Mathematics* New York: Teachers College Press, 1998 for a start on analyzing what it takes to learn to acquire and use knowledge in teaching.

[98] J. W. Little, . "Norms of Collegiality and Experimentation: Workplace Conditions of School Success. *American Educational Research Journal,* 1982 *19* (3), pp. 325-340. In a study of six elementary and secondary school staffs, researchers found that the more successful schools (Success was defined on the basis of aggregate standardized achievement scores over a three-year period in reading, language arts, and mathematics, as well as through a peer nomination procedure.)had well-established norms of collegiality and experimentation. Drawing upon methodological resources from ethnography and sociolinguistics, these researchers were able to construct sets of descriptive statements that characterized the practices and culture of each school. While there were variations among individual teachers in any single building, the researchers found prevailing patterns of approved and disapproved interaction in each school. For example, lending and borrowing materials as well as occasionally asking for advice was acceptable in all buildings. Advocating the adoption of a new idea, however, was acceptable in just four of the schools and was actively encouraged in only one. J. W. Little, "Teachers' Professional Development in a Climate of Educational Reform." *Educational Evaluation and Policy Analysis,* 1993, *15* (2), pp. 129-151.

[99] B. Showers & B. Joyce "The Evolution of Peer Coaching," *Educational Leadership,* 1996 *53*(6), pp. 12-16.

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[100] M Wideen, J. Mayer-Smith, & B. Moon. "A Critical Analysis of the Research on Learning to Teach: Making a Case For an Ecological Perspective on Inquiry." *Review of Educational Research,* 1998, *68,* pp. 130-178.

[101] M. Lampert, & C. Clark. "Expert Knowledge and Expert Thinking in Teaching: A Reply to Floden and Klinzig." *Educational Researcher,* 1990, *19*(4), pp. 21-23, 42, C. Clark, & M. Lampert "The Study of Teacher Thinking: Implications for Teacher Education." *Journal of Teacher Education,* 1986, *37* (5), pp. 27-31. J.P.A.M. Kessels and F.A.J. Korthagen, "The Relationship Between Theory and Practice: Back to the Classics." *Educational Researcher,* 1996 *25* 3, pp. 17- 22.

[102] Connecting knowing and doing *in practice* has been called deliberate action. by M. Kennedy in "Establishing Professional Schools for Teachers," in M Levine (Ed.), *Professional Practice Schools: Linking Teacher Education and School Reform* (pp. 63-80). New York: Teachers College Press, 1992. Deliberate action, like the application of technical skills, the application of concepts and principles, and the capacity for critical analysis is considered a mark of professional expertise.

[103] See H. H. Harrington and K. Quinn-Leering, "Considering Teaching's Consequences," *Teaching and Teacher Education,* in press; H. H. Harrington, "Teaching and Knowing," *Journal of Teacher Education*, May-June, 1994, *45*,. pp. 190-198; and H. H. Harrington, "Fostering Reasoned Decisions: Case Based Pedagogy and The Professional Development of Teachers," *Teaching and Teacher Education, 11,* pp. 203-214 for both empirical and philosophical evidence about ways of knowing for teaching and what preservice teachers bring to their professional education.

[104] L. Paine, and L. Ma, "Teachers Working Together: A Dialogue on Organizational and Cultural Perspectives of Chinese Teachers." *International Journal of Education Research*, 1993 *19* (8) pp. 675-697.

[105] A. E. Beaton, M. O. Martin, I. V. S. Mullis, E. J. Gonzalez, T. A. Smith, & D. L. Kelly, . *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: TIMSS International Study Center, Boston College, 1996.. A. E. Beaton, M. O. Martin, I. V. S. Mullis, E. J. Gonzalez, T. A. Smith, & D. L. Kelly, (1996). *Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: TIMSS International Study Center, Boston College, 1996. C. Kinney,. "Teachers and the Teaching Profession in Japan, " In *The Educational System in Japan: Case Study Findings* (pp. 183-253). Washington, DC: US Department of Education, 1998.

U. Milotich, "Teachers and the Teaching Profession in Germany," . In *The Educational System in Germany: Case Study Findings*. (draft volume)(pp.. 295-379).. Ann Arbor: University of Michigan Center for Human Growth and Development, 1996.

[106] C. Kinney, 1998, *op. cit.* pp. 204-205.

[107] H. Stevenson & R. Nerison-Low, *To Sum It Up: Case Studies of Education in Germany, Japan, and the United States*. (draft volume)(p. 118). Ann Arbor: University of Michigan Center for Human Growth and Development, 1997.

[108] See, for example, F. M. Newmann, & G. G. Wehlage. *Successful School Restructuring: A Report to the Public and Educators*. Center on Organization and Restructuring of Schools., University of Wisconsin-Madison, 1995. U.S. Department of Education, OERI. R117Q00005-95.

[109] V. Lee & J. Smith, "Collective Responsibility for Learning and Its Effects on Gains in Achievement and Engagement for Early Secondary School Students." *American Journal of Education*, 1996, *104*(2), pp. 103-147. J. E. Talbert, "Boundaries of Teachers' Professional Communities in U.S. High Schools: Power and Precariousness of the Subject Department." In L. S. Siskin & J. W. Little (Eds.), *The Subjects in Question: Departmental Organization and the High School* (pp. 68-94). New York: Teachers College Press, 1995.

[110] V. Lee & J. Smith, 1996, *op. cit.* This study used NELS:88 data to estimate predictors of students' 8th-10th grade learning gains. It provides evidence that affective ties among staff members directly predicts teachers' commitment and indirectly predicts students' achievement. V. Lee, J. Smith & R. G. Croninger, "How High School Organization Influences the Equitable Distribution of Learning in Mathematics and Science." *Sociology of Education, 1997, 70*: pp. 128-150. The study provides important documentation, using a national sample, that teacher community promotes equity in student learning outcomes. A "collective responsibility for learning" measure is a significant negative predictor of the slope between SES and achievement gains, as well as a positive predictor of learning gains. These findings hold up for 8th-10th grade gains and 10th-12th grade gains, with controls for average school SES, minority enrollment, school type (Catholic, independent, public) and size, and measures of the academic organization of the program and structure of the school.

[111] See J. W. Little, "The Persistence of Privacy: Autonomy and Initiative in Teachers' Relations". *Teachers College Record*, 1990, *91*, 509-536. S. J. Rosenholtz, *Teachers' Workplace: The Social Organization of Schools*. New York: Longman, 1989. M. W. McLaughlin & J. E.

Talbert, *High School Teaching in Context.* Chicago: University of Chicago Press, forthcoming. S. Feiman-Nemser & R. Floden, "The Cultures of Teaching." In M. C. Wittrock (Ed.), *Handbook of Research on Teaching* (3rd ed., pp. 505-526). New York: Macmillan, 1986. M. W. McLaughlin, "What matters most in teachers' workplace context?" In J. W. Little & M. W. McLaughlin (Eds.), *Teachers' Work: Individuals, Colleagues, and Contexts* (pp. 79-103). New York: Teachers' College, Columbia University, 1993. J. E. Talbert & M. W. McLaughlin, "Teacher Professionalism in Local School Contexts". *American Journal of Education,* 1994, *102,* 123-153. However, for an argument that research has over-emphasized "strong ties" among teachers, see Avila de Lima, 1998. Avila de Lima argues that researchers should attend more fully to limitations of strong ties (e.g., insularity) and to the possibilities for flexibility and adaptability that reside in certain kinds of "weak ties" among colleagues.

[112] V. Lee & J. Smith, 1996; *op. cit. McLaughlin* & Talbert, in press, *op. cit.*

[113] D. E. Stokes, 1997, *op. cit.*

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